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A COMPETITIVE EXAMINATION FOR DRAFTSMEN will be held at the League Island Navy Yard to fill the following positions: One first-class structural steel-work draftsmen, at $5.04 per diem, and two first-class architectural draftsmen, at $5.04 per diem. The examination will be open to all comers who can give evidence of experience in the kind of work for which they seek employment, and who are citizens of the United States. The examination will be practical in character, having reference exclusively to the requirements of the positions to be filled; the applicants' antecedents and experience, as well as the character of his previous work, will be duly considered. The structural steel-work draftsman shall be competent to detail structural steel work, and to make such computations of stresses in frame structures as required in steel building construction. Applicants for first-class architectural draftsmen will be required to show past experience, together with ability to design and develop architectural details from sketches. Applications should state name, age, residence, citizenship, present occupation and previous employment or work done; they should be addressed to the "Commandant, Navy Yard, League Island, Pa." and must be delivered to him on or before Monday, Feb. 17, 1902. A board of examiners will convene at the navy yard, League Island, Pa., on Feb. 18, or as soon thereafter as practicable. Applicants will be informed of the date upon which they will be required to report for examination.

THE ST. LAWRENCE BRIDGE CONTRACT has been let to the Atlas Construction Co., of New York, Mr. Henry Hogan, President. This is the Royal Albert bridge, connecting Montreal and Longueuil, to be built by the Montreal Bridge Co. The estimated cost of the bridge is $10,000,000.

NAMES FOR NEW NEW YORK BRIDGES have been tentatively given by Bridge Commissioner Lindenthal, the names selected having been recommended among others by the American Scenic and Historic Preservation Society. These names must be approved by the Board of Aldermen before adoption. The new suspension bridge will be called the "Navy Yard Bridge." The bridge crossing Blackwell's Island will be the "Ravenswood Bridge;" the proposed crossing of the East River at 125th St. will be the "Astoria Bridge." Heretofore the first two bridges have been simply known as bridges No. 3 and No. 4.

FRENCH CANAL IMPROVEMENT BILLS, involving an expenditure of about $132,500,000, passed the Chamber of Deputies, in Paris, on Jan. 28. It means a general renovating of old canals and building of new ones to meet pressing commercial demands in the Lorraine coal fields and other points. A Loire-Rhone and a Marseilles-Rhone canal are among those proposed.

PLANS FOR CANALS IN NORTH FRANCE are being considered, says U. S. Consul W. P. Atwell, of Roubaix. The proposed Scheldt-Meure Canal would be about 90.7 miles long, with 5.6 miles already constructed. The summit level is 721 ft. above the sea and 50 locks would be required. The estimated cost is $19,184,000. The Chiers Canal would be a continuation of the above ending at Mount St. Martin. It would be 58 miles long and cost $8,296,000. The Northern Canal would comprise three sections; Arleux to Peronne, 28 miles; Peronne to Ham, 16 miles; Ham to Noyou, 15 miles; total 59 miles. The estimated cost is $11,580,000.

THE UNION TERMINAL CO. OF NEW YORK was incorporated at Albany, on Jan. 28, with a capital of $100,000, to construct and operate an electrical tunnel, 10 miles long. The directors are F. H. Leggett, F. P. Voorhees, Roy Stone, Charles F. Smillie, L. D. Stanton, W. C. Cox, M. E. Robinson, A. D. Palmer and J. A. Stewart, all of New York city. The plans propose a tunnel starting just west of the Bergen Hills, in New Jersey, where 12 railways practically come together. The tunnel would run under the Hudson River, at a depth of 110 ft., with eight tracks, each track in a separate tube. At Union Square, 40 ft. below the surface, would be a union station, with an underground connection with the 42d St. station and two tracks under the East River to some point in Brooklyn. The idea is to build these tunnels and lease them for equipment and operation to the railway companies—provided that they want them. If they don't want them "we will not build"—says Chief Engineer Roy Stone in an interview in the New York "Sun." The estimated cost is about $40,000,000.

PROGRESS ON THE SIMPLON TUNNEL for December, 1901, is reported as follows: The advance of the two main headings aggregated 640 ft., practically all of this being in the north heading. The total advance up to the end of 1901 is, therefore, 14,500 ft. in the north heading and 20,800 ft. in the south heading, a total of 35,300 ft. The number of men employed on the tunnel during December was, on the average, 3,220, of whom 2,296 worked in the tunnel and 924 outside. The north heading was in slaty gneiss rock throughout the month, while the south heading was in a disintegrated calcareous mica-schist, requiring difficult timbering and hand drilling. The water flowing from the portals measured at the north end 27 gallons per second, and at the south end 230 gallons per second.

A GOVERNMENT EXPERIMENT STATION, for the study of sewage purification in Canada, was urged by a deputation of city officials that called on the Canadian Premier a few days ago. The government officials promised to give the matter careful attention.

A $12,000,000 SEWERAGE SYSTEM for Baltimore, Md., is proposed in a legislative bill recently drawn in that city. The bill provides for the discharge of storm water into Patapsco River and the treatment of sewage proper by some method that will give an effluent "harmless to oysters and fish in the waters of the Patapsco River or those of Chesapeake Bay." Authority to use existing storm sewers is given by the bill. The scheme is subject to approval by the city council and by popular vote.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a collision between a passenger train and a switching engine on the West Shore Ry. near Syracuse, N. Y., on Jan. 31, 1902. Fortunately no lives were lost, but half a dozen people were injured, none of them fatally.

AN UNUSUALLY DISASTROUS MINE EXPLOSION is reported from Honda, in the Province of Coahuila, Mex. On Jan. 31 a pocket of gas was struck in shaft No. 6 of the Coahuila Coal Co.'s mine at that place, and this gas exploded. According to latest reports, all of the 106 miners, at work at the time were killed, as were also all of the mules in the mine. The dead miners were for the most part Mexicans and Chinamen.

THE WAREHOUSE BUILDINGS, in Detroit, whose collapse was noted in our issue of Jan. 23, were old structures, built probably a half century or more ago and were of the common type of construction with brick walls and wooden floors. A correspondent in Detroit writes us as follows:

The building toward the middle of the block was filled with a stock of wholesale groceries and was probably loaded to about all it could stand. There was no person in either building at the time and nothing is certainly known of the cause of the collapse. Persons in the street at the time claim to have heard a report as of a muffled explosion just as the buildings fell, but there seems to have been nothing to produce it, unless gas had escaped and accumulated till it ignited a fire in a stove or furnace.

THE WATER-METER SYSTEM for Chicago is advocated by Mr. John Ericson, the City Engineer, as the best means of checking the enormous proportion of waste. In a statement submitted by him to the Commissioner of Public Works, he asserts that 75 to 85% of the total pumpage is due to waste and leaks. The average daily pumpage of water increased from 152,000,000 gallons in 1890 to 323,000,000 in 1900, and to 340,000,000 in 1901. The per capita consumption for 1890 and 1900 is given by Mr. Ericson as 126 and 161 gallons, respectively, but this is based on populations of 1,209,000 for 1890 and 2,008,000 for 1900, instead of the 1,100,000 and 1,699,000, respectively, given by the U. S. Census.

COMPENSATION FOR DAMAGES on account of the Wachusett Reservoir have been recommended by a committee appointed by Governor Crane of Massachusetts in favor of the towns of Clinton and Sterling, Mass. It is suggested that Clinton be paid $4,000 and Sterling $400 per year so long as the reservoir remains a part of the metropolitan water system. The main basis for the payments appears to be a decline in taxable values due to the taking of land for the reservoir itself and for the sanitary protection of the water supply. Some 1,400 acres of land, or about one-third of its total area, were taken in the town of Clinton and 600 to 700 acres in Sterling. The reservoir in question now forms a part of the joint supply of Boston and near-by towns.

CONTROVERSIES OVER GAS in the Cincinnati Waterworks tunnel appear to have been settled by an agreement to pay the W. J. Gawne Co., contractors, $50,000 extra on its contract price for the work. The city ordered the contract cancelled, not long ago, and on Dec. 24 it received bids for completing the work at an advance of $80,000 to $104,000 on the original contract price. An injunction suit followed.

AN EXAMINATION OF THE MATERIAL underlying the site of the Jerome Park Reservoir has been authorized by the Aqueduct Commissioners of the city of New York, in accordance with a recommendation by Mr. Wm. R. Hill, M. Am. Soc. C. E., Chief Engineer. This recommendation was embodied in a report by Mr. Hill, dated Jan. 14, on the report by Mr. Edwin F. Smith, made on Dec. 21, 1901, and given in our issue of Jan. 16. In this report by Mr. Hill, dated Jan. 14, and published in the "City Record" of Jan. 29, he merely quotes the conclusions set forth by Mr. Smith, and adds:

Before any definite plan should be adopted a further investigation of the material underlying the site of the reservoir should be made.

On the same date, Jan. 14, Mr. Hill was authorized to make the examinations recommended, subject to approval by the President.

REDUCTION OF TYPHOID FEVER in Paterson, Passaic and other communities supplied with water from the plant of the East Jersey Water Co., at Little Falls, N. J., is set forth in some detail in a report by Dr. J. L. Leal, of Paterson, N. J., Sanitary Adviser to the company. The local figures are followed by a table showing the average annual typhoid death rate for the three years 1898, 1899 and 1900 in cities in the United States of 30,000 population and upwards by the last Census. Only six cities in the east, Dr. Leal states, have a lower typhoid death rate than the communities drinking the Little Falls water. The six, with their typhoid death rates, are as follows: Rockford, Ill., 5 per 10,000; Yonkers, N. Y., 11; Elizabeth, N. J., 13; Bridgeport, Conn., 14; Fall River, Mass., 15; Malden, Mass., 16.

PLANS FOR A NEW WATER SUPPLY FOR TROY, N. Y., are now being drawn under the direction of Prof. Wm. G. Raymond, Consulting Engineer to the Department of Public Works. The general scheme has already been adopted by Mr. John Phelan, Commissioner of Public Works, and approved by the city council. The work includes an earth dam with a maximum height of 65 ft. and a length of 400 ft. on top, with a separate spillway about 300 ft. long. The dam will have a concrete core wall and will form a lake about ⅛ × 5¼ miles, with an average depth of 25 ft. There will also be a conduit consisting of about a mile of tunnel through slate rock and 38,000 ft. of 30-in. pipe. The dam will be built across Tomhammock Creek. It is designed to give a daily supply of 30,000,000 gallons, but the proposed conduit will deliver only half that amount. The estimated cost is $1,037,800, including $301,500 for land and riparian damages, engineering and legal expenses. The plans are in addition to those previously adopted for a supply from the Quackenkill. It is expected that bids will be invited this spring.

HIGH TOWERS FOR STREET LIGHTING have been abandoned at Aurora, Ill., after 20 years' use. This system of street lighting was quite commonly employed when the arc lamp was first introduced, but has been abandoned almost everywhere. The Aurora towers were 150 ft. in height. They are said to have become so weakened by corrosion that their removal was necessary.

A NICARAGUAN ELECTRIC LIGHT CONCESSION has been granted to Mr. T. M. Solomon, of the United States, and to Mr. J. Santos Ramorez, of Nicaragua, for installing electric light systems at Managua, Masaya, Granada, and Leon. While steam will first be used, the water power at Tipitapa Falls will be later utilized for generating the current for the three cities first named. The contract fixes the rates in gold as follows:

One 16-c. p. ..	$1.85
One button and switch	.85
100 ft. of wire	5.28
Monthly charge	.85

STEAM MOTOR CARS FOR RAILWAY SERVICE.

About four years ago several interesting experiments were made with independent steam motor cars, designed to operate light traffic on branch and local lines, at less cost than was practicable with an ordinary locomotive and train of two or three cars (generally nearly empty) and the requisite train crew. The idea was that with such an economical system of operation a much

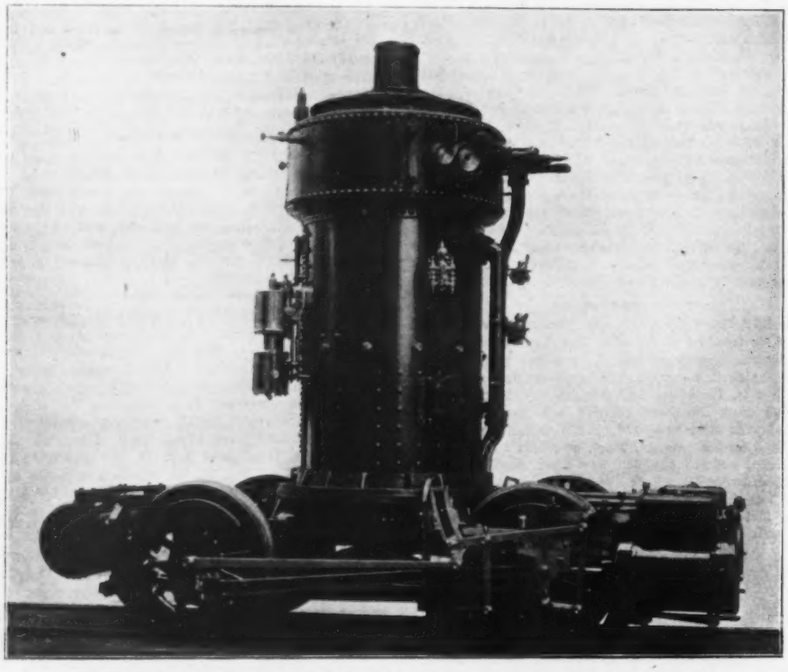

FIG. 1. ENGINE AND BOILER OF STEAM CAR OF THE NEW YORK, NEW HAVEN & HARTFORD R. R.
Schenectady Locomotive Works (American Locomotive Co.), Builders.

better service could be maintained, which in turn would develop the local traffic. The idea was a promising one, but unfortunately the results obtained were not encouraging. Some of the reasons for this are discussed in our editorial columns, and in the present article we confine ourselves mainly to a consideration of the cars actually built and put into railway service.

These railway steam cars number five in all. Two were built by the Schenectady Locomotive Works (now absorbed by the American Locomotive Co.), one of which is still in operation, while the other has been dismantled. Three were built by the Baldwin Locomotive Works; of these one is in operation (but on a private line of a mining company to which it has been sold), one is stored away in the railway company's shops, and the third has been sold and dismantled.

With this introduction we will proceed to a consideration of the five steam cars in question. We describe them somewhat in detail, because they represent an interesting departure in railway equipment and operation, and although they have by no means fulfilled the expectations concerning them, there is, we believe, a large field for the operation of improved machines of this character under conditions of light traffic or special local service auxiliary to the regular train service.

SCHENECTADY STEAM CARS.

NEW YORK, NEW HAVEN & HARTFORD R. R.—The idea of operating a steam car or composite car was suggested some four years ago by Mr. C. P. Clark, then General Manager of the New England R. R. (and now General Superintendent of the Eastern District of the New York, New Haven & Hartford R. R., which has absorbed the New England R. R.). He took the matter up with the Schenectady Locomotive Works, and the result was the machine here described. An old 60-ft. dining car was taken, and one of the six-wheel trucks was removed. This end of the car body was then altered to receive the engine or "steam truck," and the interior of the car was partitioned off to form an engine room. The passenger compartment has a seating capacity for 60 passengers.

The machine, shown in Figs. 1 and 2, has a vertical boiler, built up of steel plates ½, 9-16, and 11-16-in. thick, having single-riveted circumferential seams, and double-riveted vertical seams, and inside welt strips. The tubes are entirely submerged, but an annular chamber around the top of the boiler forms the steam space. The steam is taken from this chamber and carried directly down below the floor, and thence to the two steam chests. The exhaust is returned in a similar manner, and escapes through a 2¾-in. nozzle placed on the center of the boiler head, directly under the smokestack. As the ashpan allowed no room for eccentrics and eccentric rods, the Walschaert valve gear was adopted, being operated from a return crank on the main crank pin. The boiler is attached rigidly to the truck or engine frame, so that no flexible steam-pipe connections are required. It was necessary, however, that the truck should have a swiveling motion under the car, to facilitate the passage of curves. In order to provide for this, the car frame is carried by an annular casting, A, Fig. 2, surrounding the boiler; this casting rests upon a similar one, B, bolted to the boiler, which thus becomes practically the center pin. In grooves of the two castings were placed 125 steel balls, 1½ ins. diameter, forming an anti-friction bearing. The steam and exhaust pipes (flattened to an oval section, as shown in Fig. 2) pass inside the rings, so that no flexible connections are required for the steam pipes from the boiler to the cylinders. Anthracite coal was used for fuel and under the car were placed the water tanks of 700 gallons capacity. The general dimensions of the engine and boiler are as follows:

Wheels	3 ft. 6 ins.
Wheelbase, driving	8 " 6 "
Cylinders	12 × 16 "
Boiler, diameter	top, 5 ft. 3 ins.; bottom, 4 ft. 1 "
Working pressure	200 lbs.
Firebox, diameter	3 ft. 9½ ins.
Firebox, depth	3 " 11½ "
Water space	3 to 3½ "
Tubes	318; diameter, 1¼ ins.; height, 4 ft. 8½ ins.

The boiler, Fig. 3, is fitted with the Reagan water-grate, with rocking device operated by a lever by the engineman, no poker or slice bar being required. Anthracite coal is satisfactory, but coke gives better results. The car has been run 12 miles on one charge of coke, but the fire was by that time pretty well exhausted, and it would probably be necessary to add a small amount of fuel. Oil fuel was at one time suggested, but it was not considered advisable to carry such a large amount of oil in close proximity to a passenger compartment. The engine compartment is sheathed with asbestos board and galvanized sheet iron as a protection against fire and to prevent heat being transmitted to the passenger compartment.

The storage of water for the boiler gave rise to some trouble. The two storage tanks under the floor of the car are 24 ins. diameter and 30 ft. long, containing 1,500 gallons of water, and weighing about 12,500 lbs. when full. As the water is gradually consumed during the trip, it was necessary to so arrange the springs that the car will ride easily with a variation of load of about 12,000 lbs., and running tests made with the tanks full and empty indicated that no ordinary application of truck springs would give an easy riding body with this great variation of load. The vibration seemed to result from the dead weight of the tanks attached to the old floor, which was not designed to carry such loads. The tank hangers were then slightly changed and spiral springs were inserted between their ends and the car sills. This proved satisfactory, the springs absorbing enough of the jar to ease the frame and eliminate the vibration. Leaf springs were then substituted for the nests of coil springs, with satisfactory results. A specially-designed floor system would probably eliminate this trouble entirely, or tanks of special shape could be carried on the rear truck, fitted between the wheels.

The highest speed record is a mile in 61 seconds,

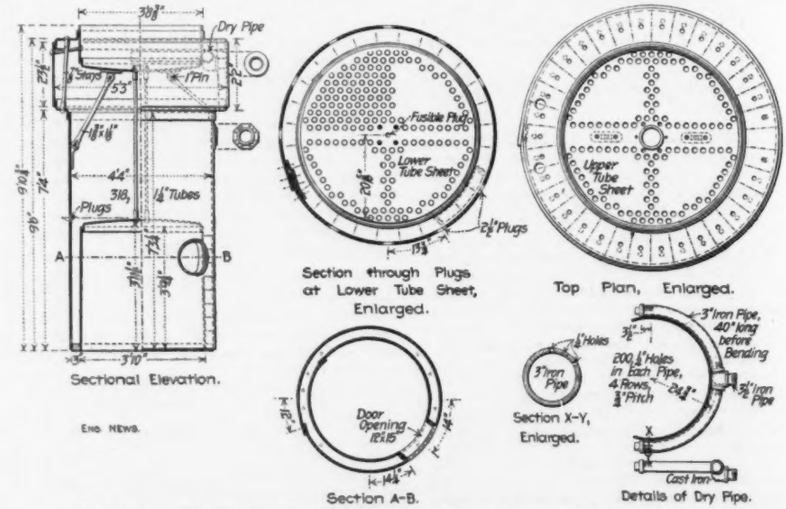

FIG. 3. VERTICAL BOILER FOR STEAM CAR; N. Y., N. H. & H. R. R.

equivalent to a rate of 59 miles an hour, requiring 472 revolutions per minute, but of course cars of this kind and in this class of service are not intended for high speeds. The longest runs have been about 120 miles, and the ordinary maximum speed is about 45 miles per hour. The water supply is sufficient for 50 miles on level track, and the bunker will hold coke enough for 100 miles. The car can haul a passenger car, and has moved 11 freight cars in an emergency. A service application of the brakes at a speed of 40 miles an hour has stopped the car in less than 500 ft. By applying the brakes by the conductor's valve, at a speed of 27 miles an hour, the throttle being open and the reverse lever in running position, the car was brought to a stop in 14 seconds in a distance of less than 250 ft. On a trial trip, up a grade three miles long, varying from 0.94% to 1.1%, the car maintained a speed of 30 miles per hour, while hauling a regular passenger car. On a level line, the steam car alone, with ¼-mile start, made a run of five miles in 5 minutes 55 seconds, the time for each mile being as follows: 1st mile, 80 seconds; 2d, 70 seconds; 3d, 65 seconds; 4th, 67 seconds; 5th, 73 seconds. The car can traverse a curve of 200 ft. radius. The car is operated by two men, an engineman and a conductor.

The car was put in service in December, 1897. Since the absorption of the New England R. R. by the New York, New Haven & Hartford R. R., this "composite" car has been used in several places, as described to us by Mr. Clark, who is now General Superintendent of the Eastern District of this road. In one place, it had three 20-mile trips in three hours, which gave 50 minutes for running and 10 minutes at each end to coal, water and turn. As about six miles of the road was on a very heavy grade (maximum 117 ft. to the mile), it was found that the service forced the boiler too severely, and as there was more or less freight work to be done during the day, the car was taken off that branch. It was next tried on Cape Cod, on a seven-mile branch with fair grades, and did work successfully, at times handling three, four, and on one occasion, six, freight cars. In switching, it has moved 11 cars at a time, although of course the steam generated will not hold out to do much work with such a load. After the summer trains were put in service, running through between Boston and Cape Cod, the "composite" was transferred to a place about ten miles from Boston, running between Dedham and Islington Junction, a distance of 2.3 miles. Here it ran for a number of months, giving satisfaction to everybody.

Although the day's work was spread over a little more than 12 hours, there were but seven round trips, occupying but 98 minutes in actual running time a day, so that it is evident no fair statement of mileage or cost of fuel can be obtained from the schedule. At that place it covered a short piece of line which the road was obliged to operate, where there was practically no business, but where it would otherwise be obliged to maintain a locomotive and car. It is still in service on that line, and was in service for 15 months without interruption. During the past summer, Mr. Clark informs us, it was taken out of service for a few weeks to have some flues renewed, after which it was again put in service. It is evident, however, that the car is not a success in the class of service for which it was intended.

ERIE R. R.—Soon after the construction of the car above described, the Erie R. R. had a very similar one built, but with a somewhat smaller car body. The engine was practically identical with the one already described, but the rear end of the car was carried by an ordinary four-wheel passenger car truck. The car was 50 ft. long. The engine and baggage room occupied a compartment 17 ft. 9 ins. long and 8 ft. 10 ins. wide, while the passenger compartment was 31 ft. 5 ins. long, with seating accommodation for 36 passengers. The car was fitted with Westinghouse brakes, heated by direct steam and lighted by electricity by a Pyle steam turbine and motor, supplying current for 22 lamps of 8 c. p in the passenger compartment and a 16-in. 32-HP. Pyle electric headlight. It had also the Golmar bell ringer operating a large gong. The boiler was fitted with two 2½-in. Crosby pop safety valves and Sellers injectors, and the firebox had rocking finger grates. The general dimensions were as follows:

Wheels, driving	3 ft. 6 ins.
Wheelbase, driving	8 " 0 "
Weight, on driving wheels	74,900 lbs.
Weight, total	114,800 "
Cylinders	12 × 16 ins.
Ports, steam	1 × 10 "
Ports, exhaust	2 × 10 "
Bridges, width	1 in.
Valve gear	Walschaert
Slide valves (American balanced), max. travel, 4½ ins.	
Lap: inside, none; outside, ⅝ "	
Boiler (vertical); diam. outside, top, 5 ft. 3 in. bottom	4 ft. 8 ins.
Thickness of plates	½, 9-16 and 11-16-in.
Horizontal seams	Double riveted, with inside welt
Circumferential seam	Single riveted
Injectors (2)	Sellers
Working pressure	200 lbs.
Firebox: diameter, 4 ft. 9⅝ ins.; depth, 4 ft. 11½ ins.	
Thickness of firebox plates	5-16 in.
Thickness of tube plates	½-in.
Water spaces, width	3 to 3½ ins.
Stay bolt, Taylor iron, diameter	1 in.
Tubes, iron; number	318
Tubes, diameter, 1¾ ins.; length over tube plates	4 ft. 8½ ins.
Heating surface; tubes	589.6 sq. ft.
" " firebox	53.3 "
" " total	642.9 "
Grate area	11.3 "
Fuel	Anthracite coal
Water (two tanks under car, 700 gallons each)	1,400 gals.

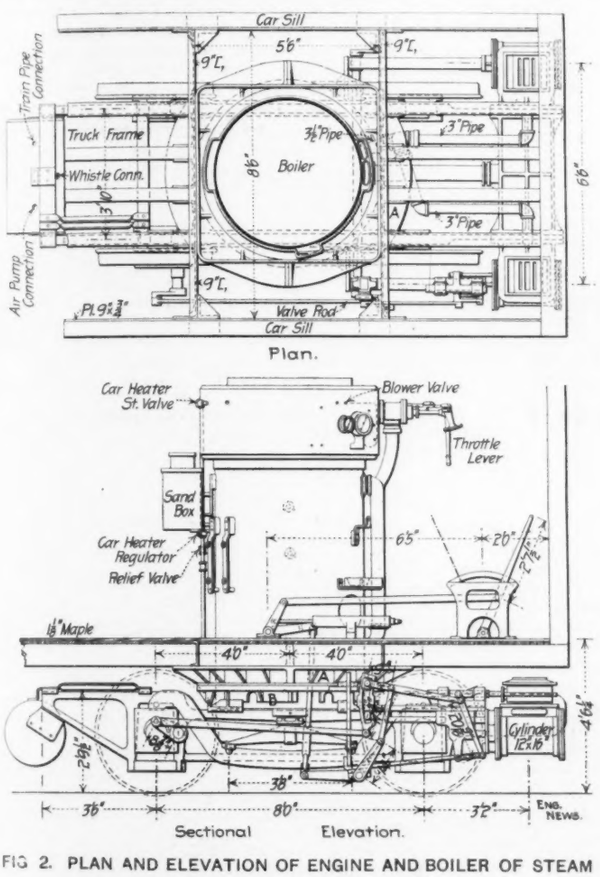

FIG. 2. PLAN AND ELEVATION OF ENGINE AND BOILER OF STEAM CAR; N. Y., N. H. & H. R. R.

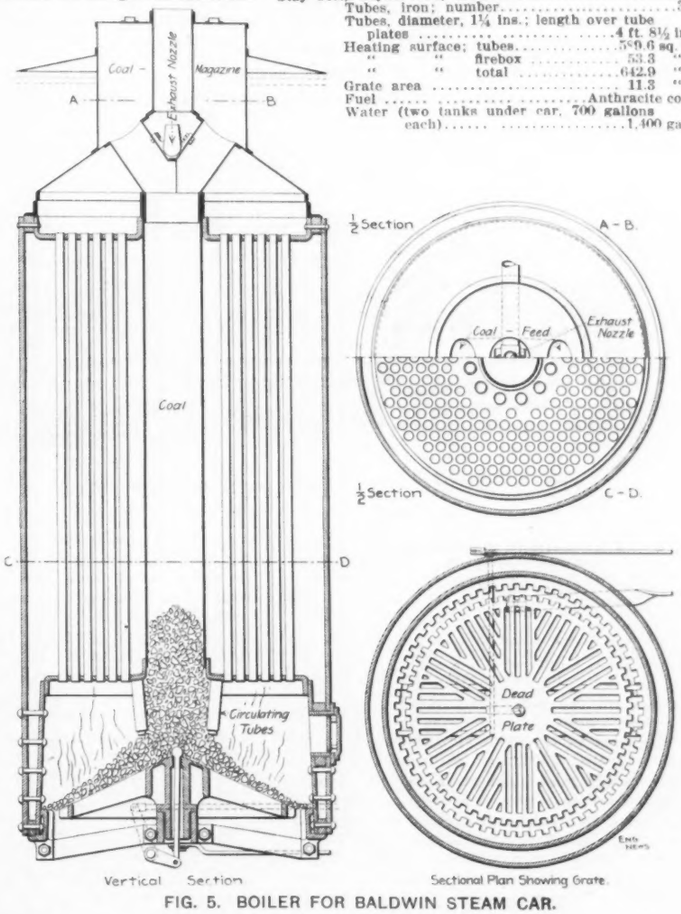

FIG. 5. BOILER FOR BALDWIN STEAM CAR.

No records of tests of the efficiency of the machine are available, but it is stated that when in service it made a daily mileage of 86 miles. This car was specially built to operate the New City branch of the New Jersey & New York R. R. (Erie Ry. system); running between Nanuet and New City, N. Y., 4 miles. It made 14 trips per day during its service of about three months, but its use was finally discontinued for the reason that it was found to be unsuitable for passenger service, being mechanically defective. From Mr. C. R. Fitch, General Manager of the Erie Ry., we learn that when the engine was in operation the jar transmitted to the passenger end of the car was so great that it made the car uncomfortable and really impracticable in operation. In addition to this defect it was found that the boiler was not of sufficient capacity to propel the car. From another official source we are informed that the car was not only too heavy on the forward truck, but that it was continually out of order for some reason or other. The car has since been dismantled and traffic on this branch is now (as formerly) operated by a train usually consisting of a locomotive, a combination baggage and smoking

car and one passenger car, requiring a train crew of four or five men.

BALDWIN STEAM CARS.

CINCINNATI, HAMILTON & DAYTON RY.—This road has for some time considered it desirable to operate an auxiliary service for its large local traffic between Cincinnati and Hamilton, 25½ miles, and the branch from Hamilton to Middletown, 14 miles, competing with an electric line between the latter points. There are 25 intermediate stations on the first line and 7 on the branch. A similar service was also proposed between Rushville and Indianapolis, 40 miles, either on the company's tracks or on independent tracks on the same right of way. For operating this service, the Cincinnati, Hamilton & Dayton Traction Co. was organized in 1897, this corporation being subsidiary to and controlled by the C., H. & D. Ry. Co. Mr. H. R. Probasco, of the traction company, wrote us some time ago in regard to this project, as follows, but so far no definite action has been taken by that company:

It was the desire of the company to obtain some other motive power than electricty, the engineers advising that this would hardly answer the purpose for long hauls. In view, also, of the enormous improvements being made it was considered unwise to go to the expense of equipping a street railway line, or lines, of the magnitude contemplated, with the possibility of finding that in a short time a practical independent motor had superseded electricity. Some time ago, at considerable expense, we investigated compressed air, but owing to the report of our engineer that that motive power had not yet arrived at a stage of practical success, we laid aside its consideration and had constructed a steam motor, which, however, did not meet our requirements, and we have since continued our investigations, and hope, in the near future, to have equipped a street railway with a motor independent of power houses upon the greater part of the right of way of the C., H. & D. Ry. Co. which, when finished, will be the most complete, and probably the longest, street railway line in this country.

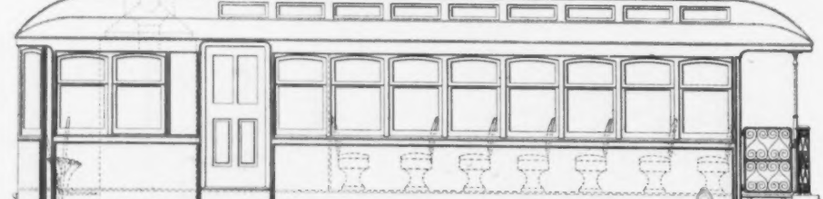

FIG. 4. STEAM CAR FOR THE CINCINNATI, HAMILTON & DAYTON RY.
Baldwin Locomotive Works, Builders.

For operating the Middletown branch, it was considered that a "steam car" would satisfactorily provide the service required, with a minimum cost for operation, and early in 1898, a car of this kind was built by the Baldwin Locomotive Works for the Cincinnati, Hamilton & Dayton Traction Co. This car, which is shown in Fig. 4, was 33 ft. long over all, mounted on a pair of four-wheel trucks, with 30-in. wheels, the forward truck being the driving truck and equipped on the Vauclain four-cylinder compound system, but with cylinders placed behind the rear axle of the truck. The gear was arranged in the usual way. Unlike the Schenectady cars, the boiler was stationary in relation to the car body, resting upon the framing of the car. Flexible connections were therefore required in the steam and exhaust pipes to allow for the swiveling motion of the driving truck, and for this purpose Moran flexible metallic joints were used.

The car had an engine compartment at the front end; a baggage compartment, 6 ft. long, and a passenger compartment with seating accommodation for 24 passengers, the car being quite short. On a trial trip, hauling a loaded box car, the machine made a run of 38 miles at a speed varying from 30 to 40 miles per hour, and the fire was given no attention during the trip.

The boiler, Fig. 5, which was the special feature of the machine, was of the vertical type, with circular firebox and conical smokebox. Circular rows of 1¼-in. tubes were fitted between the tube plates, while through the center passed a 10-in. tube, connected at the top with a coal magazine surrounding the smokestack. Around the base of this tube were 12 circulating tubes, 2 ins. diameter and 8 ins. long, projecting down into the firebox and guiding the coal to the center of the grate. Each of these tubes had a smaller one within it. The shaking grate itself was conical, the ashes emptying through an annular opening at the circumference. The solid mass of coal in the tube and between the circulating tubes prevented any escape of heat or gas except through the fire tubes. Anthracite coal was used for fuel, and was fed steadily on the grate, the jarring of the engine causing it to slide down over the conical fire surface, and the feed could be facilitated by a vertical rod passing up through the center of the grate and given a vertical motion by a lever. The center of the grate, under the coal or magazine tube, was a dead plate. The exhaust nozzle was placed under the base of the stack, between the tubes connecting the magazine with the central tube, and this arrangement served to equalize the draft through the fire tubes.

On the roof of the car was mounted a surface condenser, for disposing of the exhaust when running through the streets, but it was not intended to be used when running on the open parts of the line. This condenser had 360 brass tubes, 1½ ins. diameter. The water from the condenser drained into one of the two feed-water tanks under the car. The tanks were connected, and from one of them the boiler was supplied by two injectors. The car was equipped with the American vacuum brake on all of the wheels, a pilot at the front end, a 10-in. headlight, signal bells and a 14-in. gong. The dimensions of the engine were as follows:

Wheels, driving	2 ft. 6 ins.
Wheels, truck	2 " 6 "
Journals.....driving, 5 × 6 ins.; truck, 3½ × 7 "	
Wheelbase, driving	6 ft. 0 ins.
Wheelbase, total	16 " 8 "
Weight on driving wheels	32,000 lbs.
Weight, total	48,000 "
Cylinders (4).....5½ × 12 ins. and 9 × 12 ins.	
Boiler (½-in. shell plates), diameter	4 ft. 2 ins.
Working pressure	180 lbs.
Firebox.....diameter, 3 ft. 6⅝ ins.; depth, 1 ft. 10 ins.	
Tubes (304).....diameter, 1¼ ins.; length, 5 " 0 "	
Water (two 150-gallon tanks)	300 gallons.

This steam car was in service between Hamilton and Middletown for a few months, making about six round trips, or 168 miles, per day, but it did not prove satisfactory, and is now stored away at the railway company's shops at Lima, O. Since that time, the railway company has investigated a number of other motors, to operate a service similar to that of the electric railways, believing that a service with independent motors will be more desirable than to install an electric power plant and overhead wires for operating a trolley car service. The steam car had neither boiler capacity nor water capacity sufficient for the service required, and the loading of the coal magazine through the roof of the car gave considerable trouble. The fire needed cleaning after nearly every round trip, and this was difficult work owing to the inaccessibility of the grate. Besides this, the engine was set so close to the ground that it was impossible to get under it for inspection or road repairs except at a culvert or pit. The machine also rode very heavily. This car was intended to operate passenger service only, leaving the freight traffic to be handled by ordinary locomotives. At the present time the passenger service is provided by a light engine and two or three ordinary cars, but the same engine also handles the freight trains.

DETROIT & LIMA NORTHERN RY.—In 1898, the Baldwin Works built for this road (now the Detroit Southern Ry.) a steam car rather larger than that for the C. H. & D. Ry. The car was 55 ft. long, with engine room 15 ft. long; baggage room, 12 ft.; passenger compartment, 25 ft. and a 3-ft. rear platform. It was mounted on two trucks with 42-in. wheels; the wheelbase being 7 ft. 6 ins. for the driving truck and 7 ft. for the rear truck. It had a four-cylinder compound engine with cylinders 9½ × 18 ins. and 16 × 18 ins. The eccentric rods were placed vertically, so as to bring the valve gear above the axle and within the car, easily accessible for repair and lubrication. The vertical boiler was 5 ft. diameter, with 630 sq. ft. of heating surface; and the car carried 2 tons of coal and water sufficient for a 60-mile run. No condenser was used. The car was built to run at 40 miles an hour on the level or on easy grades, and to haul two ordinary passenger cars, while it was expected that a run of 40 miles could be made without any attention being given to the fire. Officers of the railway state that it was never in service on the railway. It was sold to the Fairfield Traction Co., of Lima, O., and was subsequently altered by reconstructing the engine to form a separate motor, and by converting the car body into an ordinary combination car.

In the steam car of the C., H. & D. Ry. the boiler rested directly on the car frame, but in the car for the D. & L. N. Ry. the frame was suspended from the boiler, which rested on the truck frame, as shown in Fig. 6. This was done for the reason that with the very large center pin (formed by the boiler), the car was apt to ride very hard, while in this case the suspension springs took up the shocks and vibration coming from the truck frame.

PITTSBURG, CINCINNATI, CHICAGO & ST. LOUIS RY.—In 1899, the Baldwin Locomotive Works built a steam motor car for this road. The car was 55 ft. long over the end sills, and had a motor compartment, 14 ft. 6 ins. long; baggage compartment, 10 ft.; and passenger compartment 30 ft. 6 ins., with seating accommodation for 40 passengers. The forward end of the car was carried by four driving wheels and a two-wheel pony truck, with solid plate pilot in front. The rear end of the car was supported by a four-wheel truck. The weight was 116,000 lbs., of which 79,000 lbs. were carried by the driving wheels and front truck, and 37,000 lbs. by the rear truck. The cylinders were placed ahead of the truck, instead of behind it as in the C. H. & D. steam car. The engine was of the Vauclain four-cylinder compound type, with cylinders 9½ × 18 ins. and 16 × 18 ins.; driving wheels, 3 ft. 8 ins. diameter; driving wheelbase, 7 ft. 8 ins.; total wheelbase, 48 ft. 6 ins. The valve gear was of the Stephenson shifting link type. A vertical boiler of the submerged flue type was used, having a self-feeding coal magazine around the smokestack, with a capacity of 2,500 lbs. The boiler was 5 ft. diameter, and had 380 tubes, 1½ ins. diameter and 3 ft. 4 ins. long. The firebox was 4 ft. 6 ins. diameter and 2 ft. 6 ins. high, with 860 sq. ft. of heating surface. The working pressure was 185 lbs. A condenser with 1,500 sq. ft. of cooling surface in 1½-in. brass tubes was placed on the roof of the car, and into this was turned the exhaust of the engine and the brake pumps, the water of condensation being led to two feed water tanks of 500 gallons capacity each, under the floor of the car.

The machine was built to run on the branch from Xenia to Springfield, O., 19 miles, to give a better and more economical service than could be operated with a locomotive and cars, this new service being instituted in view of competition from a new electric railway. The machine was intended to have a speed capacity of 30 miles an hour, hauling two or three ordinary cars. It did not meet these conditions, however, owing mainly to trouble with the boiler. The self-feeding arrangement for the fuel did not work satisfactorily, and the steaming capacity was entirely insufficient to meet the requirements. After being in service about a month, the car was withdrawn from service. It was sub-

sequently sold to the Clearfield Bituminous Coal Co., and used in passenger service on the company's private line between its mines and the town of Punxsutawney, Pa. The ordinary style of service has since been in use on the Springfield branch but electric traction on the trolley system is now to be adopted.

OPINIONS AS TO STEAM CARS.

The opinions of the two principal builders as to the utility of these steam cars are somewhat at variance. The American Locomotive Co. writes us as follows in regard to the Schenectady cars:

> While these (two) engines accomplished all that was promised for them, we feel that for this service a light locomotive separate from the car is a better arrangement than a combined locomotive and car.

On the other hand, the Baldwin Locomotive Works admit difficulties which rendered the first engines unsatisfactory, but express their approval of the principle involved, as follows:

> There seems to be a considerable demand for a motor car capable of seating about 40 passengers and carrying baggage. The problem appeared to be well worked out in the two cars constructed respectively for the P., C., C. & St. L. Ry. and the Detroit & Lima Northern Ry. The objections to them, however, were limited boiler capacity, the necessity for using small driving wheels (thereby involving a high rate of rotation at any satisfactory speed), the difficulty of making the car body ride smoothly with one end carried by the locomotive, and inaccessibility of machinery for attention and repairs. The most important difficulties were those of making the car ride smoothly, but notwithstanding the greatest amount of time and attention devoted to this subject by both ourselves and Mr. S. P. Bush, then Superintendent of Motive Power of the P., C., C. & St. L. Ry., we were unable to accomplish it. In a vertical boiler it is also difficult to keep the tubes tight, on account of the sediment deposited around the bottom ends of the tubes, together with problems of expansion. We do not consider it impossible to work out a satisfactory solution of the matter, but it must be done on other lines than those of ordinary locomotive construction. We have been so much occupied with other work that we have been compelled to lay this problem aside. Meanwhile we have declined to undertake the construction of such machines.

The mechanical difficulties with these cars have been somewhat numerous. The automatic stoking has not given satisfactory results, its operation being somewhat uncertain, involving trouble in maintaining steam. The tubes have developed a tendency to become overheated, and the boiler capacity has in most cases been found to be insufficient for the service required. The cars have been found to ride very hard on the track, especially at the engine end; and the weight of the tanks under the body and of the condensers sometimes placed upon the roof, have caused unpleasant vibration and swaying of the car. Some of the cars have also been found to be very noisy. To increase the steaming capacity, oil fuel has been experimented with, but so far without success, mainly for the reason that in the vertical boilers used on these cars there is not room available in the firebox for the long flame which is requisite for a proper combustion of oil fuel.

COOKE STEAM CAR.

ERIE & WYOMING VALLEY R. R.—In this connection mention may be made of a private steam car built in 1899 by the Cooke Locomotive Works (now absorbed by the American Locomotive Co.), for Mr. George B. Smith, President of the Erie & Wyoming Valley Ry., before that line was purchased by the Erie Ry. Many railway officers have inspection cars consisting of an eight-wheel engine with a house enclosing the boiler, but Mr. Smith's car was more convenient and comfortable. The car was 19 ft. 4 ins. long over the body, with a 2½-ft. platform at each end, while the width was 9 ft. 6 ins. The front end contained the saloon, with four seats and a couch, while at the rear end was a compartment containing the vertical boiler, coal bunker, etc. A toilet room was between the two main compartments. The horizontal cylinder was 8½ × 8½ ins., driving a single pair of wheels 3 ft. 6 ins. diameter; with a leading four-wheel truck, and a single pair of trailing wheels. The boiler was 4 ft. diameter, carrying 165 lbs. pressure, and the firebox was 3 ft. 6 ins. diameter and 3 ft. deep. A steam brake was used.

THE ROWAN CAR.

One objection that has been made to the steam car is that any defect in either the car or the engine puts the whole machine out of service, while the combination makes it difficult to execute repairs. For these reasons it has been suggested that the engine portion and the car portion should be separated, so that either part may be sent to the proper shop for repairs. This might seem to indicate the use of the dummy engine again, but to avoid the rattling and vibration, due to the comparatively loose couplings of the old-style dummy engines, the improved construction would include either a vestibule connection or an arrangement by which the front ends of the car sills would be supported on the engine frame. This latter system has been employed in the Rowan steam car, which has been extensively used abroad (Eng. News, Oct. 15, 1896). In this car, the forward end is hinged and can be thrown open to clear the boiler; the frame is then jacked up and the steam truck run out, and another put in place. The front end of the car is partitioned off and forms the engine room and coal bunker.

Of course, where steam car service is established, the machine must be in duplicate or the ordinary train service must occasionally be renewed when the steam car is sent to the shop for periodical washing of the boiler or general repairs.

MISCELLANEOUS SYSTEMS.

Various other systems of independent motor cars, operated by steam, compressed air or oil engines have been experimented with. In 1899, a motor car of generally similar type was built by the Vimotum Car Co., of Chicago, and tried on the Pennsylvania Lines, at Indianapolis, but this never got beyond the experimental stage. The car resembled those used on interurban electric railways, and was 41 ft. 6 ins. long, and 8 ft. 6 ins. wide, mounted on a pair of four-wheel trucks with 33-in. wheels. The front end of the car was supported by a steel bolster supported by the outside frame of the truck. On the forward truck (and within the car) was mounted a 45-HP. Wolverine vertical three-cylinder gas engine, belted to a countershaft, while a second countershaft carried a pinion which engaged with a spur wheel on the front axle. Each countershaft had a pulley of variable diameter, connected by a stiff belt, this arrangement forming the Reeves variable-speed transmission system, described in our issue of March 1, 1900. The machinery was supported on an inside frame of the driving truck. The car carried a water tank for the circulating system of the cylinder jackets, and was fitted with the Christensen air brake. It weighed about 22 tons, and was designed for a speed of 25 miles per hour, although it attained a speed of 40 miles an hour on a trial trip. Nothing came of this, but the company has since been working on a steam car, having a triple-expansion marine engine to drive a similar transmission system. The Compressed Air Co., of New York, was at one time working on plans for a large car to operate on suburban service as a main line of railway, but no such car has been put in service.

The Patton motor had a gas engine and dynamos for charging storage batteries which furnished the power, but most of these machines were built as separate motor cars. The Kinetic motor was on the steam storage system, the superheated water being stored under high pressure and flashing into steam when admitted to the cylinders at reduced pressure. A few of these cars have been built, and two of them (seating 25 persons each) were put in service on the 1½-mile railway at Babylon, N. Y. The Prall motor, which has been experimented with on the New York Central Ry. (some of the railway company's officers being interested financially), is on the same principle, but does not appear to have achieved any practical success. Both the Kinetic and Prall motors are somewhat similar to the Lamm-Francq motors which have been used for several years on street railways and light railways in France and elsewhere, but generally employed as separate motor cars.

A somewhat new development in this line appears to have recently been made in Austria. It is reported that the Minister of Railways has ordered an "automobile" car, operated by a Daimler oil engine, for service on the Southwestern Ry. The car resembles an ordinary European passenger car, seating 32 persons, and has the 30-HP. four-cylinder motor placed under the frame. The car is operated by one man, the controlling apparatus being placed at both ends of the car, and a speed of 30 miles an hour is said to be attainable. A car of this kind is expected to permit of very economical working on local lines in thinly-populated districts, and consequently a more frequent service and better connections with the main lines, by which means the traffic will probably be increased.

Steam "dummy" engines hauling trail cars are still in use on a number of minor street and suburban railways in the United States, but the speed is limited, partly on account of the rocking and swinging motion, both of the engine and cars. In many cases, the old dummy engines were operated in a reckless way, and were given very little attention, so that they became noisy, dirty and leaky, with the natural result that they were very objectionable, and led to a general public dislike to this system of traction. This objection, however, does not apply to the system in itself. In a paper on "Steam Motor Cars," read by Mr. Vauclain, of the Baldwin Locomotive Works, before the New York Railroad Club, in April, 1898, it was stated that in suburban service with steam "dummy" engines, at Kansas City, the cost for all expenses, repairs, wages, etc., in maintenance, averaged only 5.66 cts. per mile run, although the lines had grades as heavy as 5 and 5½%.

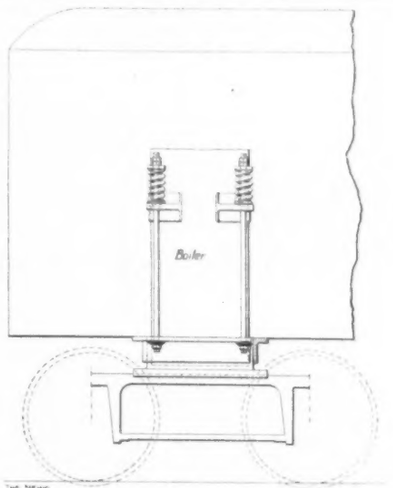

Fig. 6. Suspension Arrangement for Steam Car of the Detroit & Lima Northern Ry.

THE COST OF CATALOGUING BOOKS in a library is set down at about 15 cts. per title by Mr. Wm. Coolidge Lane, the Librarian of Harvard University, in the last annual report of that institution. This covers the making of the card alone; and the report goes on to say that the cost of the various operations which must be performed between the first indication that a certain book is desired in the Library and the placing of the book upon the shelves averages about one dollar, and may exceed the cost of the book itself. It is not generally known that the now familiar card catalogue, arranged in drawers, with sloping blocks, guide-boards and removable wire through the cards, was devised 40 years ago by Mr. Ezra Abbot, Assistant Librarian at Harvard University. The Library of Congress has commenced recataloguing its whole collection of books on printed cards. And these cards will be offered for sale at 2 cts. for the first card and ½ ct. for all duplicate cards. The actual distribution of these cards has not yet commenced; but librarians believe that in time this plan will largely reduce the cost of the individual cataloguing of standard books, in saving labor and printing. These cards will cover three classes of books in the National Library: (1) All books currently copyrighted under the laws of the United States. (2) All miscellaneous material, current and non-current, acquired by it. (3) All printed books in the present collection, as these are reached in the reclassification process now going on. In the latter division, American history and library economy, including bibliography, have been reached; political economy will next be taken up.

A BONUS FOR THE TREATMENT OF AURIFEROUS black-sand, amounting to $10,000, is offered by the Minister of Mines, New Zealand. The plans or appliances must be sent to his office before Jan. 1, 1904, and the treatment proposed must be successful in saving gold from the black-sand of New Zealand.

THE NEW YORK RAPID TRANSIT RAILWAY.
II.
Six Years' Labor for Municipal Rapid Transit.

THE RAPID TRANSIT COMMISSION OF 1894.—The Rapid Transit Act of 1894 was an amendment of the act of 1891. Its most important provisions may be summed up briefly as follows: (1) The commissioners were named by the act itself, and given power to fill vacancies independently of any control but the act itself. (2) The choice between the construction of the railway by the city itself and its construction by private capital was required to be decided by popular vote at a regular city election. (3) In case the verdict of the people was expressed against construction for and at the expense of the city, the commission was to sell the right, privilege and franchise to construct, maintain and operate the road to a private corporation at public auction. (4) In case the people should determine by vote to construct the road for and at the expense of the city, the commission was thereupon to make a contract in behalf of the city for the construction of the railway at the expense of the city. The manner in which this contract was to be carried out and in which the money required for construction was to be provided was fully stated in the act, and will be outlined in a succeeding paragraph. The provisions of the act which stipulated the mode of procedure of the commission in deciding upon the route and plan of construction, and in securing the consent to construction of the City Council and abutting property-owners, or, in default of the latter, the approval of the Supreme Court, were substantially as in the act of 1891.

The members of the new Rapid Transit Board were as follows: Mayor Thos. F. Gilroy, City Comptroller Ashbel P. Fitch, and President Alex. P. Orr, New York Chamber of Commerce, all members *ex-officio*; Messrs. Wm. Steinway, Seth Low, John Claflin, John H. Starin and John H. Inman, members named in the act. The commissioners met on June 18, 1894, and completed its organization by electing Mr. Alexander E. Orr, President, and appointing Mr. Wm. Barclay Parsons, M. Am. Soc. C. E., Chief Engineer. At a meeting on July 17, the board provisionally adopted the plans and routes laid down by the commission of 1891. At the same meeting the Chief Engineer, Mr. Wm. Barclay Parsons, was instructed to proceed to Europe to investigate and report upon the various systems of rapid transit prevailing in European cities.* At the following November elections the citizens of New York voted in favor of the construction of the road for and at the expense of the city.

Immediately after this favorable action was known, the commission made an announcement of the future course of action which it intended to pursue. This was, briefly, to reconsider the whole subject and make any changes in the routes and extent of the line, and in the general plan of construction which might seem necessary. One special feature of the modifications was to be the location of an additional route on the east side, which should better meet the needs of that crowded section of the city. These changes of route would require a new procedure to obtain the consents of the property-owners along the new lines, and while this was being done the engineers of the commission would be engaged in the preparation of detailed plans and specifications suitable for the use of contractors in the preparation of bids. When routes and plans had been adopted and detailed drawings and specifications were made, the commission was to proceed to let contracts for construction.

Pursuant to this scheme of action the commission on Nov. 13, 1894, instructed its chief engineer to report upon the objections, if any existed, to the plans of construction of the commission of 1891, provisionally adopted, and to make such suggestions as seemed pertinent. On Dec. 21, 1894, Mr. Parsons presented his report,† the principal features of which were as follows: It was suggested that, owing to the many objections which were certain to assail any plan providing for a line under lower Broadway, a two-track line should be laid out from South Ferry up Broad St., and Nassau St., to the City Hall, and from there a four-track line carried up New Elm St., to Union Square. In case this suggestion did not meet with the approval of the commission, the report advocated that the plans be changed to provide for a double-track subway at the shallow depth below the street surface for local trains and below this a parallel double tunnel line for express trains. This report was concurred in by

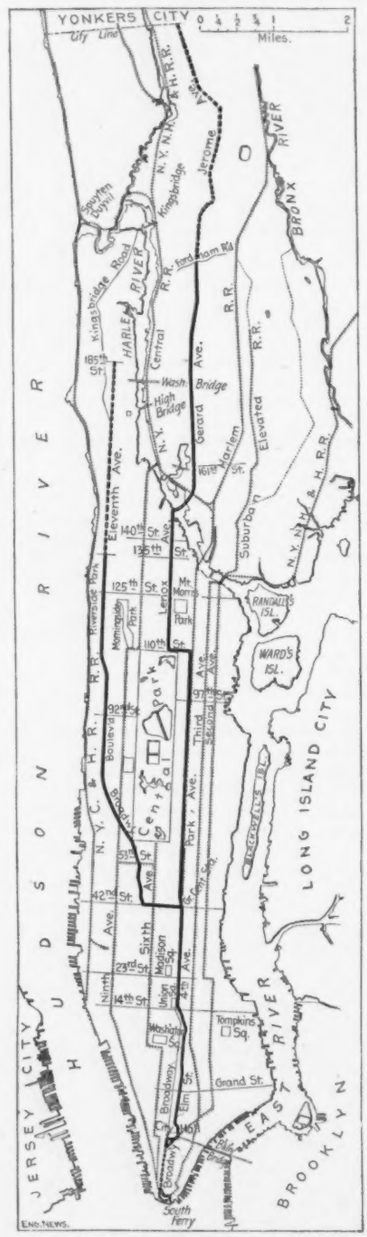

Fig. 2. Original Route for Rapid Transit Railway Adopted by the Rapid Transit Railroad Commission of 1894.

Mr. Alphonse Fteley, M. Am. Soc. C. E., and Mr. Theodore Cooper, M. Am. Soc. C. E., the consulting engineers retained by Mr. Parsons. Upon receipt of the report the commission appointed a Board of Experts to consider its recommendations, and incidentally to consider generally the rapid transit problem.

The Board of Experts appointed by the commission consisted of Mr. Abram S. Hewitt and of Messrs. Octave Chanute, Thos. C. Clarke, Wm. H. Burr and Charles Sooysmith, M's Am. Soc. C. E., and it made its report on Jan. 29, 1895.* This report supported Mr. Parsons in his objections to the plans of construction adopted by the commission of 1891; approved the new plan of construction recommended by him; and verified his estimates of the probable cost of construction. It, however, concluded that the provisional line adopted by the commission, viz., the original line of the commission of 1891, was impracticable, as its cost would exceed the $50,000,000 imposed as the limit of cost by the Rapid Transit Act, but that the route and plan of construction might be so modified as to bring the cost of construction within the legal limits. In accordance with this conclusion, it recommended the "following route and number of tracks for present construction":

Two-track subway from South Ferry to City Hall Park, under Broadway, with loops at Battery and City Hall Parks.

Four-track subway from City Hall Park, under Elm St. and Lafayette Place to 14th St.

Two-track subway in rock tunnel under Broadway, from 14th St. to 25th St., for express trains, to be built without breaking surface of Broadway.

Four-track subway under Fourth Ave. from 14th St. to 23d St., and two-track subway under 23d St. to Broadway for the local trains, joining the express subway at 25th St.

Four-track subway under Broadway from 25th St. to 92d St., to be constructed on different levels at least as far as 34th St.

Four-track structure, mainly viaduct (with subway under Morningside Plateau), along the Boulevard and 11th Ave., from 92d St. to 185th St.

Four-track subway under Fourth Ave. from 23d St. to the Grand Central Station.

Two-track subway under Fourth Ave. from the Grand Central Station to 97th St.

Two-track viaduct along Fourth Ave. from 97th St., thence crossing the Harlem River to Mott Haven.

At a meeting of the commission on Feb. 5, 1895, the recommendation that New Elm St. be substituted for Broadway, between the City Hall and 14th St., was discarded, and at the succeeding meeting of Feb. 13, the commission voted to adhere substantially to the route laid down by the commission of 1891, and already provisionally adopted by itself. On May 3, 1895, an act of the State Legislature giving the commission authority to expend $5,000,000 to acquire the vault space along Broadway was approved by the Mayor, and a few days afterward the commission submitted its route and general plan of construction to the City Council for approval. The plan of construction submitted provided that the tracks were to be placed substantially upon a level, and that the railway was to be placed as near the surface of the street as practicable. The Common Council formally approved the plans on May 21, 1895.

The next step of the commission was to seek to secure the consents of the property-owners, but in this work they failed, as did the commission of 1891. Resort was then had to the Supreme Court, which appointed three commissioners, whose approval of the plans, according to the Rapid Transit Act, if granted and confirmed by the court, would give the Rapid Transit Commission power to proceed without the consent of the property-owners. These commissioners, after some objections on the part of the hostile property-owners, were appointed in November, 1895, and in March, 1896, they submitted a report approving the plans of the Rapid Transit Commission. On May 22, 1896, the Supreme Court handed down a decision on the verdict of its commissioners, which surprised everyone by practically reversing that verdict. The grounds upon which the court based its decision were: (1) The great and alleged uncertain cost of the enterprise, and (2) the heavy expenditures which had raised the city's indebtedness so near the constitutional limitation that it was a question whether money sufficient to build the Rapid Transit road could be legally raised. At this point it is of incidental interest to note that one of the pleas upon which the hostile property-owners had fought the commission was that the Rapid Transit Act was unconstitutional, and that on July 28 the court handed down a decision declaring the act constitutional. This decision left the commission with only the charges of excessive cost and municipal poverty to meet.

Hardly had the adverse decision of the court been made public when the Manhattan Ry. Co. approached the commission with a proposition that it be allowed to make several extensions. At the meeting of the commission on Aug. 6, 1896, this request was denied, and at the same meeting the following resolution was passed:

Resolved, That the Chief Engineer be, and he hereby is, directed to submit to this board at as early a date as

*Mr. Parsons' report was made in October, 1894, and was published in full in Engineering News of Oct. 18, 1894.

†This report, with the accompanying plans, was published in Engineering News of Dec. 27, 1894.

*This report was published in full in Engineering News of Jan. 31, 1895.

possible routes and a general plan of rapid transit which shall conform to the following conditions:

1. Total cost after abundant allowance for contingencies, not to exceed $30,000,000.

2. Route to proceed from the southern terminus at or near the Post Office and under the City Hall Park and Park Row to Elm St. and Fourth Ave. to or near the Grand Central Station, and there to divide into the east and west side routes. The west side route to proceed under 42d St. to Broadway and the Boulevard to a point above 125th St. The east side route to proceed under Park Ave. and over private property to the Harlem River and across and beyond the Harlem River to as distant a point as the proposed limit of cost will permit.

3. The railroad to have four tracks to the junction of the east and west side routes and above that point two tracks on each route, except that a third track for express service shall be added on both routes when conveniently and economically possible.

4. The road to be in a tunnel, except on the east side, north of 98th St. and on the west side at Manhatttan valley, 125th St.

5. Plans to be so drawn as to permit further extensions in the future from the south and north termini and permitting the two and three-track portions to be widened into a four-track system without unnecessary expense or interruption of traffic.

In pursuance to this resolution a report was presented on Nov. 5, 1896, by Chief Engineer Wm. Barclay Parsons, laying down a new route and a system of construction so planned that the number of tracks might be increased whenever the demand arose for them. Fig. 2 shows the line of the adopted route. The construction in subway, which was recommended, was steel column and roof-beam bents carrying side walls and a roof of concrete, and resting on a concrete floor.* At its meeting on Dec. 31, the commission provisionally adopted the new route, and a fortnight later, on Jan. 14, 1897, it formally approved the route. On March 23 the Common Council approved the new route, and work was begun to secure the consents of the abutting property-owners. These consents could not be secured, and late in May the commission appealed to the Supreme Court for the appointment of special commissioners to decide upon the necessity for the road. These commissioners were appointed and immediately began their deliberations. Before their report could be made, however, the public received the astounding announcement from the Park Board that it would refuse to approve the route unless it were changed so as not to disturb a number of the park trees. The vigorous arraignment of the proposed action by the public, however, caused the Park Board to withdraw its objections, and to approve the route as it stood. This was a most fortunate outcome. Under the terms of the law any change in the route after its approval by the mayor and common council was invalid, and had the Park Board insisted upon a change the Rapid Transit Commission would have been forced to begin anew all its work of securing the approval of the common council, the consents of the abutting property-owners, etc.

Early in November, 1897, the commissioners appointed by the Supreme Court reported in favor of the enterprise, and on Dec. 17, the court itself approved the report. Attached to this approval, however, were several stipulations, the most important of which by far was the requirement that the commission should exact a bond of $15,000,000 from the contractor who should undertake the construction, equipment and operation of the road. The duration of this bond was not stated. Hardly had this decision been published when the usual crop of "announcements" sprung up to the bewilderment of the public. To summarize briefly, Mayor Van Wyck announced in his inaugural address that the city was too poor to build a rapid transit railway, and that the Manhattan Ry. should be compelled to equip its lines for electric traction, and to build extensions. The Manhattan Ry. Co. announced that it had decided to make the improvements urged by the mayor. The Metropolitan Transit Co., which had been organized some time before to build the rapid transit railway, announced that it would withdraw from the field. The Rapid Transit Commission announced that until it was known what the Manhattan Co. would or would not do, it was useless to expect bidders for the rapid transit franchise.

Time and patience were wasted in futile discussion of these announcements until March, 1898, when the Appellate Division of the Supreme Court announced that $1,000,000 of the required $15,000,000 bond demanded of the contractor was to be continuous, but that the remaining $14,000,000 should endure only during the period of construction. At the same time the Rapid Transit Commission suggested a deposit of $1,000,000 by the contractor to be returned upon completion of construction and equipment; the withholding of a reasonable percentage of the price of construction to be paid upon completion; a bond not to exceed $7,500,000, to secure construction and equipment; a lien upon the equipment, and, lastly, a bond which, with the cash value of the equipment, should equal the estimated rental for seven years. With this announcement the prospects for rapid transit assumed a more hopeful outlook, but this condition did not last long, for in May, 1898, the City Comptroller handed down a ruling that the city had already reached its constitutional debt limit. This ruling, coupled with the outbreak of the Spanish-American war, and its disturbing effect on securities, effectually put a quietus to rapid transit matters for some months.

Practically the first movement to be made by the commission to free itself from the restrictions of the Comptroller's debt limit ruling took place at the meeting of Dec. 15, 1898, when it was decided to appeal to the State Legislature for relief from that impediment. On Feb. 22, 1899, such a bill was introduced into the legislature. Early in March the commission received an offer from the Metropolitan Street Ry. Co., to build and operate the proposed rapid transit railway under certain stated conditions, the most important of which was that it should be granted a perpetual franchise. This offer met with favor on the part of some of the commissioners, but public feeling was so strongly expressed against the perpetual

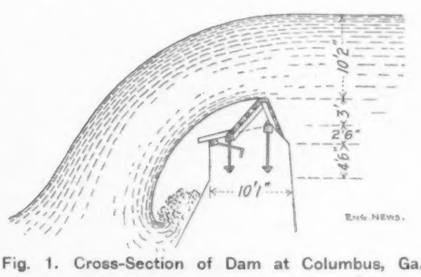

Fig. 1. Cross-Section of Dam at Columbus, Ga.

(In our issues of Jan. 9 and 23 the two lower vertical dimensions were given as 4 and 2 ft., respectively. Mr. Hardaway now corrects these to 4½ and 2½ ft., as shown.—Ed.)

franchise clause that the Metropolitan Co. withdrew its offer on April 17. A week later the bill before the legislature, which, among other things, gave the Rapid Transit Commission power to grant a perpetual franchise for a rapid transit railway, was killed by the opposition of Governor Roosevelt. Meanwhile the Comptroller's debt limit ruling had brought forth fruit of another sort. It meant not only that there was not money to build a rapid transit railway, but that there was no money for improvements of any character. This was a condition decidedly alarming to the powers in control, and they made haste to correct it by increasing the tax assessments of the city. To the Rapid Transit Commission this increase opened the way for steps toward immediate construction, and early in November, 1899, the commission advertised for proposals for constructing, equipping and operating under lease the proposed underground road, the bids to be received on Jan. 15, 1900. At last, after more than a decade of planning and contriving, of controversy and litigation, of alternate hope and disappointment, the city of New York had reached the point of advertising for bids for the construction and operation of a rapid transit railway.

On Jan. 15, 1900, the New York Rapid Transit Railroad Commission received two bids for constructing, equipping and operating the underground railway called for in its plans and specifications. One bid was from Mr. John B. McDonald, and the price stated was $35,000,000; the other bid was from Mr. Andrew Onderdonk, and the price stated was $39,303,000. On Jan. 16, the bid of Mr. McDonald was accepted, and he was called upon to qualify for the contract. Considerable delay was experienced in arranging the exact terms of qualification, but they were finally settled upon as follows: A bond from Mr. McDonald for $1,000,000; a bond from the construction company organized to take over the contract from Mr. McDonald for $4,000,000; a bond from surety companies for $1,000,000; and cash from the construction company for $2,000,000. Meanwhile a bill had been passed through the New York State Legislature authorizing the City Comptroller to issue bonds for construction without the concurrence of the New York Municipal Assembly, and the financial details of the work had been placed entirely in the hands of August Belmont & Co, by the contractor. On Feb. 19 articles of incorporation of the Rapid Transit Subway Co. were filed at Albany, N. Y., with Mr. August Belmont as President, and a few days later Mr. McDonald formally turned his contract over to this company. On March 2, 1900, the Board of Estimate and Apportionment of New York city authorized the issue of $36,500,000 of bonds to pay for the construction of the road.

*This report was published nearly in full in Engineering News of Nov. 12, 1896.

REMARKS ON THE RECENT FAILURES OF MASONRY DAMS IN THE SOUTH.

By B. H. Hardaway.*

The failure of four masonry dams in the Southeastern States under nearly the same comparative conditions, and the consequent loss of property and of time to the various enterprises dependent upon these dams, amounting in the aggregate to probably $700,000, should cause earnest investigation by the engineering profession.

These dams were all of recent construction and of practically the same general type. They were designed by different engineers and built by different contractors under the supervision and inspection of the engineers in charge of the work, and in their several failures developed a remarkable uniformity in result.

The river at Columbus, Ga., drains an area of about 4,500 square miles, and the dam of the Columbus Power Co. was subjected to a rise of 13 ft. 2 ins. over the crest of the stone work. The flood on the upper dam at Tallassee, Ala., was 10 ft. 4 ins.; on the lower dam at Tallassee, Ala., 6 ft. 8 ins.; and on the dam near Anderson, S. C., 7 ft. 6 ins.

The dam at Columbus, Ga., was the only one of the four that had wooden flash boards on it, and locally the disaster is attributed to this cause, as the part of the dam which did not have the flash boards erected did not fail, although exposed to strong current. These flash boards, Fig. 1, reached a distance of 3 ft. above the apex of the stone masonry, and the water rose 10 ft. 2 ins. above the top of the flash boards. The dam gave way in just the two points where the currents were strongest, namely: Over the old river channel, and at the point on the curve of the dam where the water caught by the funnel-shaped forebay was thrown with most velocity over the dam. (See remarks, further along, on the location of the dam.—Ed.)

The flash boards which were not washed away were greatly twisted and damaged, and it is probable that over the broken sections the flash boards first gave way, and collapsing, dropped the whole weight of the water on the spillway through a distance of 3 ft. on the dam, with its downward and forward impact causing immediate rupture. However, the maximum known rise in the river would have caused a 14-ft. rise on the spillway, instead of 10 ft. 2 ins., and it is practically conclusive that the dam under such a rise would have failed without the flash boards.

It seems that not enough consideration is given in the design of such dams to the stresses caused by impacts and heavy spillway shocks. These are live loads, and the total stresses must not exceed the elastic limit of resistance, or say one-half the breaking strain or ultimate resistance of the dam. That is, that under all conditions and at all times the factor of safety shall be more than two.

A bridge engineer considers it absolutely necessary to use a factor of safety of four against static or dead loads, and a factor of six against live loads, and this practice meets general approval.

Immense structural masses where the load is nearly all dead, like the Croton dams, may be

*Engineer and Contractor, Columbus, Ga.

planned with safety sailing close to the wind, but an apex of masonry vibrating under a live load of from 10 to 15 ft. of water thundering over its crest in rivers whose beds fall from 30 to 40 ft. to the mile, should be given every provision of shape and weight necessary absolutely to resist the pressures and shocks they must encounter.

Under these conditions, one impression made on the observer is that the spill leaves the rollway under the pressure of pond velocity and strikes the dam at its lower half with full force, bearing little resemblance to the usual drawing.

When the dam at Columbus failed it had a factor of safety of about 1.5 against the static load. An examination of this type is shown in Fig. 2.

For simplicity the broken lines of the section are thrown into an equivalent quadrilateral, and the amount and kind of load and equivalent load and point of application are shown graphically.

The static pressure for a 14-ft. head is 30,150 lbs., acting through a lever arm of 7.33 ft., giving a result of 221,100 ft.-lbs. The resistance is 236 cu. ft. of masonry at 140 lbs. per cu. ft., multiplied by a lever arm of 10.3 ft., giving 340,312 ft.-lbs. Or a factor of safety of 1.5 against static loads, instead of more than two in order to also cover dynamic loads.

A head of 10 ft. on the spillway of Fig. 2 gives a factor of safety of about two, and is not safe.

In the above discussion no account was taken of any vertical pressure from water flowing over the crest of the dam, it being regarded as of doubtful value. Nor was any account taken of back water, since no larger factor of safety per-

seams and fissures under them, and it is his opinion that masonry of all sorts will absorb both water and pressure when exposed to them, and that on these accounts the masonry in dams should not be figured at a weight of more than 125 lbs. per cu. ft.

For dams with their crests forming a waste weir it seems as if a good empirical rule would be to use a width on top of never less than the greatest

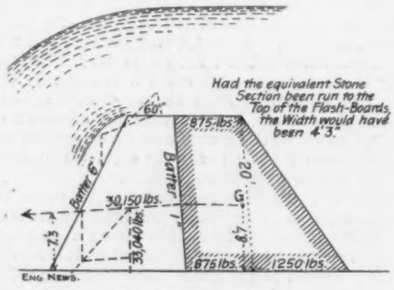

Fig. 2. Study of Dam at Columbus, Ga.

depth of water on the spillway when using the usual battered section of which this dam was a type. Had the battered faces in this section been extended to the top of the wooden flash boards the width would have been 4 ft. 3 ins.

Probably the provisions against failures like the one described will be found along the lines of

views, Figs. 3 and 4, then turns and crosses its entire bed, 800 ft. wide, at right angles to the Georgia side, which latter it then follows for some distance.

The dam, after crossing the channel on the Alabama side, curved down stream so as to meet the power house into the old bed of the river, and the bulkhead wall in front of the power house (Fig. 1, in your issue of Jan. 23), just on the edge of the channel, in order to save tail-race excavation.

This somewhat unusual construction caused two separate and distinct river crossings. As the water here was about 40 ft. deep and 100 ft. wide, and the dam 60 ft. high from the foundation to the top of the masonry in the bed of the stream, the cofferdams all had to be 40 ft. high, making a difficult piece of work.

The foreground of Fig. 3 shows one of the cofferdams across the main channel of the river. The clay chambers in these cofferdams were 30 ft. wide, and the sheeting for the clay chambers were held in place by cribs 12 × 16 ft., filled with stone. The view, Fig. 4, shows the masonry at this point when it was nearing completion.

The masonry in this dam was rubble work, composed of large stone, many of which contained from 4 to 6 yds. The faces and top for a width of 3 ft. were laid in Portland cement mortar, one part of cement and three parts sand. The interior was filled with large stone placed carefully, so as to bond, and the interstices filled with spawls and broken rock. This interior was carefully grouted with one part of Louisville cement to two parts of

FIG. 3. VIEW OF DAM UNDER CONSTRUCTION AT COLUMBUS, GA., BEFORE THE WRECK.

tains above back water than below it, and much of the back water was caused by the construction.

The Columbus dam did not leak, and great care was taken in its construction in order to get safe foundation and good work.

It is the experience of the writer that dams founded on tertiary rocks have water-bearing

ascertaining the exact weight of masonry under the conditions to which it is subjected, and in making the width on the top of dams greater and in giving more batter to the up-stream face, or giving a long rollway to the down-stream face.

At the site of the Columbus dam the river comes down on the Alabama side, along the site of the

sand, with sufficient water to cause the mixture to flow freely. The grouting was done in layers of about 24 ins., and the fractures on the dam show that the process gave good results, leaving the voids filled with hard and well-set mortar. This method was used throughout the dam, with the exception of the last section, built over the

current of the river, which was built uniformly in mortar of one part Portland cement and three parts sand.

The writer notices the discussion in the issue of the Engineering News of Jan. 16, relative to this process of grouting, and although he prefers that the stones be set in mortar of concrete, he agrees with Mr. Philbrick in the opinion that grouting is a practical method to secure good results in the building of dams, and that if the work is well and carefully done, and a fair cross-section given, no trouble will be experienced from leakage or breakage. It is notable in this instance that the western edge of the break on the Alabama side, which was immediately in line with the current of the river, broke in the middle of the only section of the dam that had been laid altogether in Portland cement. This would tend to show that the currents are very strong in producing dynamic strains; sufficiently so to overcome minor differences in the proportions of cement used in the mortar.

Fig. 5 shows a wooden dam at Columbus which has stood for many years, being originally built before the civil war, and repaired in the eighties. It is of ancient and excellent type, as the line of equivalent water pressure cuts the base within the vertical letfall from the center of gravity of the structure.

Fig. 6 shows the dam of the Eagle & Phenix Mills Co., at Columbus, Ga., built in 1878, and which is now in good shape.

Fig. 7 shows the section adopted by the City Mills Co., at Columbus, Ga., for its stone dam, which it expects to build this summer. It has enough slope on the up-stream side to take care of the water pressure, and enough slope on the down-stream side to prevent undue compression to the masonry and the foundation. All the three last-mentioned dams, however, under extreme conditions, have their crests submerged by back water.

The breaking of the dam of the Columbus Power Co. caused an immediate fall in its pond of 7 ft., and a consequent sudden rise and fall of 5 ft. on the crest of the City Mills dam, ¾-mile below, and a consequent rise and fall of 3 ft. 3 ins. on the crest of the Eagle & Phenix dam, ¾-mile further down the river.

WATER COST AND WATER WASTE.*

By A. L. Holmes.†

In the water plants of this state, the different modes of getting the supplies and the sources from which water is obtained will show a little difference in the cost to deliver a thousand gallons to consumers in different towns.

At Ishpeming, for instance, a short line from an elevated lake a couple of miles from town [originally?] delivered by gravity the water under about 45 lbs. pressure to the lower part of the city. Fire service is furnished the city by a pumping plant using the conduit line for a suction pipe. This pipe line, costing about $50,000, has supplied the town for a dozen years and some 10,000 consumers have had cheap water.

The yearly cost of pumping has been about $300, and until the past year no attempt has been made to restrict the waste that has well nigh ruined the efficiency of the

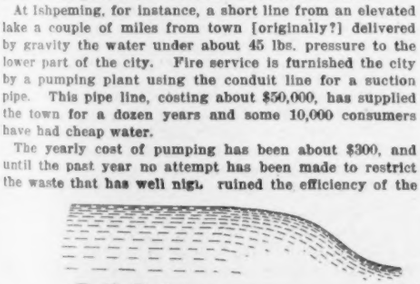

Fig. 5. Old Timber Dam of City Mills Co., Columbus, Ga.

plant and dropped the pressure in the mains in the business part of the town, from 45 lbs. to one-half of that amount.

In many of the towns using about one to two million gallons daily, I find a record of about $5.50 to $6.50 per 1,000,000 gallons for fuel, pumping generally against about 100 ft. of elevation.

The cost of water delivered into the mains in the city of Grand Rapids, taking the report of the board of public works for 1900 as authority, was about 4¼ cts. per 1,000 gallons, and the water department received for the year's pumping $100,982, or about 2½ cts. per 1,000 gallons. The cost of fuel for pumping a million gallons against 200 ft. was $4.08.

In Kalamazoo, the cost of pumping 1,250,000 gallons per day last year was, for fuel, an average of $6.72, or at the rate of $5.50 per 1,000,000 gallons.

In towns using an average of 500,000 gallons or less per day, and with a population of 2,500 to 5,000, the unit cost will be double the amounts given, and in many towns with old pumps and boilers and poor attendants this may be again doubled.

Where the consumption reaches half a million or more and a stand-pipe or reservoir can be utilized, compound pumps will lower the cost considerably.

Again, we come to the natural gas region of Indiana and Ohio, and find many of the plants with their own gas wells, using compressed air and delivering water to consumers as cheaply as is done by gravity plants. These gas reservoirs have been largely exhausted, and these towns must now turn to other sources of power.

But to get at the cost of water delivered by our water plants, we have other items besides fuel consumption to reckon with: These should include interest charges; a sinking fund sufficient to extinguish the debt in 20 years; maintenance, operation and depreciation. The latter item under intelligent management may be largely cared for in the yearly repair account.

This leaves the pipe line extensions to be made in the same manner as the original plant was built, which is proper, but not always practicable. Such extensions are often met from the water revenues, and the sinking fund unprovided for. In many cases the interest on the bonded plant is paid by the city at large in lieu of hydrant rental, and as one about offsets the other, no great injustice is done.

There are few among our smaller plants that can afford to sell water for less than 15 cts. a 1,000 gallons.

Some of the engineers in charge of the planning and constructing of water-works plants seem to have lost sight of the financial part of the transaction as it relates to the future operation of the works, and the idea of receiving more money for water sold than it costs the municipality seems never to have occurred to them. Evidently they look at water-works management as they do at the handling of the police force, or the fire department, and entirely forget that the municipal water departments are attempting to collect sufficient revenue from consumers to care for the investment and cost of operating the plant.

The manner of attempting to set a price on a commodity the amount of which we are in ignorance of, is about as hard a problem as can be placed before any water-works superintendent.

The fact is that we do not sell the water at all, for we don't know how much is used, but we lease the right to handle the faucet at the consumer's own sweet will.

The cost of reasonably pure water suitable for domestic use will increase in our municipalities for some time to come, for there is urgent need of changing half of the plants in use to-day; few have a quality of water safe or satisfactory. What I call a new "water end," which means a new location and source of supply with new and modern machinery, large intakes and force mains to strengthen the present piping service for fire service is the need of more than 50% of the water-works in this country.

Filtration is rapidly coming to many of our cities, and this will in many cases double the cost of water to the producer.

As I have said, the price of water for domestic uses must increase to the producer, and unless the waste, which equals one-half of the pumping, is stopped very largely, the schedule rates must be increased to pay the expense of operating.

FIG. 4. VIEW OF GAP IN DAM AT COLUMBUS, GA., NEARLY CLOSED.

The plant in Grand Rapids was built nearly 30 years ago and has not received as much from the sale of water in that time as the plant has cost, allowing the interest paid to offset the cost of hydrant rental, and now there faces the city the expenditure of at least a million dollars for a pure water supply and proper distribution system. When we have a plant properly constructed and in condition to do business with a good supply of water of fair quality which consumers must have, and deliver it under a pressure that makes it available for all purposes, then it becomes very necessary that we receive pay in proportion to the water supplied to the consumer.

There is only one way by which this can be done, and there is no plant that can operate on a hit-and-miss schedule rate and receive income enough to make the plant self-supporting from water alone. But when the plant is operated on a meter basis, and the parties who use the water pay a fair price for it, with a reasonable minimum charge to secure the use of enough water for sanitary purposes, then the water-works system passes from an uncertainty to a profitable enterprise,, and the benefits of our installation of coal saving devices are secured.

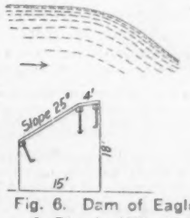

Fig. 6. Dam of Eagle & Phenix Mills Co., Columbus, Ga.

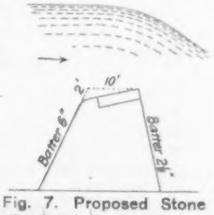

Fig. 7. Proposed Stone Dam for City Mills Co., Columbus, Ga.

We can then control and regulate the enormous waste that has bankrupted many of the franchise plants and forced the most of the municipal plants to depend for their supplies upon foul and contaminated streams.

I think it will not be out of place to quote here from the reports made by the officers in charge of some water plants that have tried the meter plan for the sale of water.*

The water commissioner, Mr. George Houston, of Kalamazoo, Mich., in his last annual report says:

I am greatly pleased to call your attention to the fact

*Abstract of a paper read before the Michigan Engineering Society at its annual meeting in Grand Rapids, Mich., Jan. 8, 1902.

†Hydraulic Engineer, Grand Rapids, Mich.

*Some of these extracts have been condensed.—Ed.

that the records for the year 1893 show that the daily pumpage of water amounted to 2,150,000 gallons, while for the year just passed (1900) only 1,223,000 were pumped, or a decrease of 927,000 gallons daily, while the population of the city has materially increased (and over 300 services have been added since 1893, an increase of more than 10%). The great decrease is undoubtedly due to the use of meters placed since 1893.

It is also a noteworthy fact that no complaint has been made during the past winter about the Vine St. sewer overflowing, as was the former rule, and no doubt, as suggested in my former report, the said sewer will now be found large enough for years to come, providing all places having sewer connections are required to be metered.

I wish now to quote history, as taken from the reports of the Board of Public Works of Grand Rapids for the year ending April 30, 1900.

Reference to the secretary's report will show that the cost of maintenance and operating the water-works system for the year was $48,083; interest and exchange, $39,262; total, $87,345.

The surplus income was expended in the extension and relaying of mains, and in the purchase and setting of meters. Much more could be profitably expended in these lines, but it has not been deemed expedient to ask the council to issue bonds or levy a tax for these purposes.

It is deemed advisable to increase the number of meters as rapidly as possible, because it has been found impracticable to stop waste and leakage in any other manner, and schedule rates cannot be arranged to be just to all consumers. Many pay less than they did by schedule rate, and the aggregate receipts from metered water may be little more than was received from scheduled rates for the small consumers, but it is certain that they effect a decrease in the waste.

That there is an enormous waste is apparent from comparison of the amounts of water pumped with the receipts and number of consumers. The receipts are lower in proportion to the water pumped than in any city with which we exchange reports. A million gallons of water at 3½ cts. per 100 cu. ft., which is the present minimum meter rate, is worth $46.67. To pump an average of 12,000,000 gallons per day and sell it at the lowest metered rate would make the gross income $204,400 per year.

Estimating the plant at $1,200,000; the cost of maintenance $50,000; interest at 5%, $60,000; taxes at 1½%, $18,000; depreciation at 5%, $60,000; will show that the income must be increased to $136,653 before the plant can be considered as permanently self-sustaining.

If the rate of increase made during the past year can be maintained for two years, the income will be over $190,000, and it is believed it can be done if the department can obtain a fair compensation for water furnished for schools, parks, cemeteries and fire hydrants.

I will also quote from the same board made a year later, or last May, 1901. In part they say:

The buying and setting of additional meters would also prove profitable to the department in the way of stopping waste and thus save fuel by decreasing the amount of water necessary to supply the demand as is plainly shown by the following statement:

The daily average amount of water pumped in four weeks ending April 26, 1899 was 13,479,088 gallons. During the succeeding year 618 meters were installed, and in the four weeks ending April 24, 1900, the daily average of water pumped was 11,858,802 gallons, a decrease of 1,620,826 gallons per day.

During the past year 910 meters have been set, making the total number set 2,103. During the four weeks ending April 5, 1901, the daily average water pumped was 9,724,550 gallons, or 2,134,252 gallons less than last year, and 3,754,836 less than the corresponding four weeks in 1899.

The reduction in amount of water pumped not only reduces the coal bill, but relieves the strain on the pumping machinery that existed a year or two ago.

If the setting of meters can be continued, it will soon be practicable to do all the pumping with one pump, except in times of extraordinary consumption of water.

This language by the Board of Public Works in 1901 is in striking contrast to the agitation in this same board previous to 1899 for a new 20,000,000-gallon pump, and the facts were then shown that the pumping was increasing at the rate of about 12% yearly, and that the machinery was then taxed to a dangerous degree at certain times of the day for domestic service. And all sorts of dire disaster was predicted by some members of the board and by the engineer in charge of the plant if there was delay in making the purchase and incurring the expense of about $70,000 for an outfit to consume more fuel and increase the cost of maintenance and operation without increase of revenue or giving more people water service.

I also wish to quote from the annual report of the city of Fremont, O., dated May 1, 1901. The trustees say:

We call your attention to the fact that the earnings are over $3,000 more than last year (a gain of 30%), and the advance in receipts is due to the placing of 95 meters from which we have had the revenue for the last six months of the year. The amount of water pumped the last six months of the year has been reduced more than one-half. The amount of coal consumed has been reduced from five tons every 24 hours to two tons.

The testing of the water wells has proved that they will produce 500,000 gallons every 24 hours, and when all services are metered it will not require to exceed 750,000 gallons every day to supply the demand. With a few more wells the city would be supplied with pure well water.

Unless every tap was metered, it would be the height of folly to attempt to keep up the supply, as the leaks and waste would be carefully attended to by the consumers if metered, whereas, if not metered, the leaks and waste would continue.

Of course the question of cost of metering a city comes up, and as in the nature of things cities cannot have a surplus of money in their water department for the purchase of meters, it is often asked me how this can be done.

The first thing necessary with the management is to know that they need and want meters, and then it is very essential that they have a good stiff back bone, for interested persons who own leaky plumbing and have use for more water than they have paid for will not submit to correction without a vigorous kick, and in many cases they are able to induce aldermen and those who can influence officials to help them kick. If they have this nerve and are bound to bring the pumping to approximately the amount paid for, they can place meters on the services in the same manner that most of the cities lay water pipe extensions, from the revenues.

While many cities compel the water users to pay for the meters in advance, as does Milwaukee, Rochester, N.Y., and Kalamazoo, Mich., I think an easier way, and one that creates less friction, is for the city to own and set the meters and to keep them in repair, charging such rates as is necessary for water and covering the meter expenses and cost in this manner.

When you meter a system of water-works, you secure a complete control of the output, and can place the rates where the revenues will pay the plant's expenses; it will not only pay for the meters, but will furnish means to buy pumps and pipe lines as well.

Of course we all realize that the consumers of water pay for the meters any how that you manage it; but if he pays for it in water rates, the same as he pays for the mains and fire hydrants, he does not notice it as he does if he planks down $15 in advance. In Chicago, it costs the consumer $50 to get a meter set on his premises, while $18 is the price in Milwaukee that the plumber extracts from the householder for a meter set in the basement.

In many small cities meters are set in basements at about a dollar each, and in Fort Wayne, Ind., the cost is less than that amount. Battle Creek's engineer in charge of the water department takes a good deal of pains to have meters set in a brick well below the cellar bottom, and reports the cost of setting them at $3 each.

In many of our cities the pipe lines are offering too much friction resistance for the amount of water we are attempting to force through them, and the cry goes up on all sides that larger lines must be laid. Well, if we cut off this waste and reduce our pumping by one-half, don't we double the size of our pipes and increase the carrying capacity of them?

In the endeavor to furnish cheap water for elevators, small manufacturers, fans, etc., we have gone into a field that had better be left to the electrician.

I believe in getting the purest water available, keeping it in clean reservoirs and delivering it to the consumers in this same healthful state. I would have the supply ample, the storage sufficient beyond any question, and I would deliver it to the user at as near the cost price as safety would permit. I would make that consumer responsible for the leaks and wastes in his plumbing, delivering the water to his property line where I would measure it, and treating him as he is treated in all other business lines—ask him to pay his share for the support of this system.

There is little opposition among the people for whose opinion one may care, to the meter system of regulating waste; for when we find a water consumer that objects to paying for the water used, that is about the place a meter had better be placed.

The first object of setting meters is to stop waste, and if incidentally, they allow us to regulate the revenue and give equity and justice between the water company and the consumer, we cannot object to that.

Water Consumption per Tap in 12 Metered and 3 Unmetered Cities.

Population.	City.	Taps—Per ct. metered.	Taps—Actual No.	Consumption per tap.
65,000	Atlanta, Ga.	92	9,300	587
29,000	Atlantic City, N. J.	80	4,250	538
62,000	Des Moines, Ia.	60	7,500	400
85,000	Dayton, O.	50	12,000	440
30,000	Racine, Wis.	25	5,000	280
104,000	Fall River, Mass.	95	7,000	548
187,000	Providence, R. I.	83	22,000	470
56,000	Utica, N. Y.	97	7,000	425
57,000	Lawrence, Mass.	75	6,000	540
33,000	Newton, Mass.	85	7,000	295
125,000	St. Paul, Minn.	30	17,000	490
113,000	Worcester, Mass.	95	13,000	596
87,000	Grand Rapids, Mich.	20	10,500	1,200
35,000	South Bend, Ind.	5	5,000	1,250
65,000	Saginaw, Mich.	3	5,000	1,500

CIVILIZATION AND WAGON ROADS.*

By Ira O. Baker, M. Am. Soc. C. E.†

"The roads of a country are accurate and certain tests of its civilization." Considering roads in the broadest sense as means of communication and transport on land, and thus as including railroads, wagon roads, and city streets, it is true that the degree of civilization which any people have attained is indicated by the condition of their roads; but if by roads is meant only those traversed by wagons, it is not true that the condition of the roads measures the civilization of a country. The condition of the wagon roads is dependent upon other elements than the state of civilization; as, for example, upon the density of population, the frequency of the use of roads, the character of traffic, the kind of crops, the topography, the opportunity for drainage, the proximity of suitable road-building material, etc. As a rule the condition of the wagon roads is no indication of the degree of civilization of the local community.

The problem of good roads depends in every case upon local conditions, and no general solution can be found. The broken stone road in the moist climate of France is an ideal road, but in the dry climate of northern Italy it becomes a dusty nuisance. The broken stone road may be well suited to the soil and climate of England, but who can foretell the effect of sticky Illinois mud on such a road? The principles and practices of France, England, Germany and Switzerland, although most excellent for those countries, are not necessarily applicable in this country. The wagon ways of the leading European countries represent the experience of centuries in road building, and the chief motive in the construction of many of them was military rather than commercial or social. Those countries have a dense and comparatively wealthy population, an undulating surface affording ready drainage, and an abundance of suitable material for constructing permanently good roads; while in the United States are immense areas having a sparse and comparatively poor population, without gravel or broken stone suitable for road-building purposes. Further, the advent of the railroad has materially changed the condition with reference to many of the European wagon roads.

The first inhabitants of this country were too fully occupied in subduing the wilderness, establishing homes, opening farms to provide the necessaries of life, and setting up the framework of a government, to give much attention to the conveniences and comforts of transportation; and hence their wagon roads were of the crudest and poorest sort. Later, just as an extension of the population to the west necessitated the development of better means of transportation, the introduction of the railroad made less important the wagon roads and engrossed the attention of the population of the new territory. In a large part of the United States the railroad has been the pioneer and has rendered unnecessary long lines of wagon transportation. At present this country is so well supplied with excellently managed railroads, that the chief function of the wagon road is to afford easy communication and transportation between neighboring farms, and between the farm and the nearest railroad station. Thus the problem of good roads has become a local question both with respect to the community the road serves and to the materials and methods most suitable for use in the construction.

The writer has collected the following data for the benefit of the good-road enthusiast who is always so ready to compare the justly celebrated road system of France with that of America, much to the disparagement of the latter. France has one mile of road for each 0.66 sq. mile of area; Massachusetts, one mile of road for each 0.48 sq. mile of area; New York, 0.61; Illinois, 0.53, and New Jersey, 0.43. In other words, the states above noted have about as much highway per sq. mile as France. Again France has one mile of road for each 119 of population; Massachusetts, 164; New Jersey, 100; New York, 90, and Illinois, 46. The population of France is about four times as dense as that of Illinois. Road laborers receive 50 cts. per day in France, and $1.50 in America. The annual expense on the roads of France is $143 per mile of road, $223 per sq. mile and $1.39 per inhabitant; in Massachusetts, $22.17 per mile, $50.72 per sq. mile, and 46 cts. per capita; in New Jersey, $43.24 per mile of road, $100.06 per sq. mile, and 43 cts. per capita; in New York, $30 per mile of road, $49.20 per sq. mile, and 33 cts. per capita; in Illinois, $34.86 per mile of road, $65.80 per sq. mile, and 77 cts. per capita. In other words, France is spending nearly three times as much per mile of road as Illinois, a half more per square mile, and about the same per capita.

In Champaign county, 18% of all the taxes is spent upon road and bridges. It is interesting to note that in Massachusetts (the only state that has collected the data) that the per cent. of total tax receipts spent upon the roads is practically the same in the rural districts as in the cities, being 13.7% in the former and 11.2 in the latter.

The good-road enthusiast who writes so glibly that the condition of the roads indicates the state of civilization and who reiterates the praises of the stone roads of France and England, is prone to denounce the prairie roads of the Mississippi Valley and of Illinois in particular, as the worst imaginable. On the contrary, I believe that the roads in the "corn belt" of Illinois are among the best in the country, and that with a little intelligent care they can be made on the whole second to none. The earth roads in the prairie portion of Illinois are usually excellent during eight months and in some years ten months of the twelve; and ordinarily they are reasonably good for ten or twelve months of the year, but there are times in the spring when the frost is going out of the ground that they are practically impassable for loads. However, through the underdrainage of the soil by tile and through a better care of the surface, the period of impassability is comparatively short. There has been a very great improvement in these directions in recent years, but there is still room for discriminating improvement.

The earth roads of the prairie states are easily cared for and usually are kept in reasonably good condition. If you think the roads of the "corn belt" are bad, go to a locality where sand predominates; and after wallowing through sand half hub deep, you will probably long for the mud roads of Illinois. Or go to a hilly or even an undulating locality, where the roads are guilied out by

*A paper read at the annual meeting of the Illinois Society of Engineers and Surveyors.

†Professor of Civil Engineering, University of Illinois.

the rails and where the stones stick above the ground or roll around on the surface, and after grinding along on the pebbles, jolting over the stones, and climbing up and down hill for a half day, you may prefer the smooth level roads of Illinois for business purpose and perhaps for pleasure driving. The hill country is a very good place to spend a summer's vacation, provided you do not attempt much driving; but for every-day use, there are some advantages in favor of prairie roads.

Unfortunately the good-road enthusiast has sought to improve the roads of the prairie states by trying to prove to the farmer that he would save vast sums of money in the marketing of his produce by the construction of stone roads. The farmer has been marketing his farm products for a good many years and has not been conscious that it has cost him much if anything; and he cannot see how he will save money by spending large sums to build and maintain expensive stone roads, when all of his transportation on "poor" roads costs him little or nothing. Many of the farmers of Illinois have had experience with hard roads in the Eastern states, and believe as an octogenarian, whose letter shows him to be an educated, observant, public-spirited man, wrote to the author a short time ago:

I feel satisfied from my own experience in Illinois and in Massachusetts, that if we had hard roads [in Illinois] the increased expense of repairing wagons and shoeing horses and of the bother and cost of having a lame horse in the barn eating his head off, would be more than the total cost of marketing our products over earth roads. I do not believe that I would have received one dollar more for the produce I have delivered to the railroad station for the last 40 years, even if the roads had been made of the best stone or brick.

The farmer has turned an indifferent or hostile ear to all such advocates; and if these arguments have accomplished anything, it has been to retard road improvement.

Many of the arguments of good-road enthusiasts are so unreasonable as really to do more harm than good. For example, what is the probable effect upon the farmers when the council of a city having no pavements appoints a committee of citizens to urge farmers to build hard roads costing $10,000 per mile past farms worth $5,000, with a house every half mile, to connect with an unpaved street with houses every hundred feet, as was done in one case to the personal knowledge of the writer? The said committee has not yet had a meeting!

Although the road question is local in its nature, it is not unimportant in its relation to the political and social development of the country. The political and social life of the states, as well as their economic advance, is to a considerable extent determined by the readiness with which the people obtain the association with one another, which leads to the development of a public spirit. In closing the writer urges that the advocates of road improvement should base their arguments on social, educational, and political grounds and not alone, nor even chiefly, upon commercial needs; and that much more attention should be given to the local conditions; and finally that it is not wise to advocate high-priced broken-stone roads as substitutes for poorly cared-for earth ones.

RECORDS OF THE MAINTENANCE-OF-WAY DEPARTMENT; RIO GRANDE, SIERRA MADRE & PACIFIC RAILWAY.*

By L. P. Atwood.†

This road has but one division, about 156 miles in length. As Engineer of Maintenance of Way, I have charge of tracks, bridges and buildings, and their appurtenances. The operating force subordinate to this office, consists of one bridge gang (a foreman and five laborers); 22 section foremen, mostly with one laborer each, but aggregating 28 laborers for the 22 sections, and an extra foreman for special work. All are Mexicans, excepting the bridge foreman. Native carpenters are generally employed to do any building repairs needed.

All foremen are required to send their time books to this office by the last train of each month. The pay rolls are made up from these books, after checking them over, and entering necessary deductions. For a record of the distribution of the labor, an ordinary day book of 300 pages is used. For each month two pages are ordinarily required. The left-hand page is ruled into vertical columns, each marked at the top to show the different kinds or classes of work done during the month. For instance, column (1) is usually "track repairs," including all ordinary work of a section gang; (2) is "switch repairs;" (3) "tie renewals," etc. If one page should not be enough, two would be used. Each gang is given one line, and its time, in dollars and cents, is entered in the proper columns, and the total pay roll of the gang entered in the last column. This is done direct from the time books, and on completion the footing of the last column is checked against the pay-roll footings. Each column is then marked at the bottom with the number of the account on the auditor's general distribution sheet, to which said labor is chargeable. A summary of these accounts is then made on the opposite page, together with a detailed record of all new or special work. From this page the distribution sheet and the extraordinary disbursement sheet are filled out, and together with the pay rolls are forwarded to the auditor's office. There should never need to be any occasion to go back of this distribution book for information as to past labor performed.

Each man on the rolls is then furnished with a card giving his name, station, amount earned, deductions, and amount due, for presentation at the pay car. A material statement is then made up from carpenter's job slips and my own memoranda made during the month, and sent to the storekeeper, an impression copy being kept. This statement does not include material bought for specific and immediate use. When I "O. K." such bills I mark same with the work, and amount number, chargeable, and write a letter to the storekeeper, copying the bill or bills together with the charges, taking an impression in a copy book. It also does not include supplies, tools, and material covered by stub requisitions, these last being handled by the storekeeper. Time books and job slips are filed away for a year and destroyed.

The bridge construction book is ruled into vertical columns headed with all sizes and dimensions of material, both lumber and iron, used in the bridges, and each bridge occupies a line on the page. This gives in detail, and concisely, the material in the structure. Then farther on in the book are recorded the details covering each structure, bent by bent, both pile and frame. Thus far all renewals have been recorded alongside corresponding construction record, giving cause of renewal, and all data necessary to keep complete records.

Tie-renewal records are kept in a 200-page day book. Each kilometer occupies half a page, and at the end a summary of total renewals for each month is made, as well as a summary for each section for each month. This book will last for many years. This covers all labor and material records made solely for purposes of record.

In doing work and for compilation purposes, two ordinary field books are kept in use, one marked "Engineering Notes and Surveys," containing notes of the staking out of buildings, tanks, turnouts, cross sections for ditching, grading, etc.; the other is marked "Road Book," and contains road inventories, track material used or transferred, etc. A third book is kept in the desk and seldom leaves the office. In it are posted all items of material and labor used in the construction and renewals of all structures pertaining to the building department. These books, when filled, are properly indexed and filed.

When a foreman discharges an employee, he issues a time certificate that is exchanged for a stub time check in this office, and the latter can be cashed with the nearest agent. The time certificates are usually kept on file only three months. Stock-accident reports are made out by foremen. A duplicate is made and filed in this office, and the original forwarded to the general manager's office. Hospital permits are addressed to the nearest company surgeon, and a duplicate kept on file. These last blanks are not issued to foremen.

I drew up a form for track material reports at the beginning of operation, when we expected to use American foremen, and afterwards found it impracticable to get native foremen to comprehend them, and as the division was short, and work light, I have kept much data myself in the above-mentioned "Road Notes" book.

I use a vest-pocket record of the curvature, alinement and gradients of the division. The book is 2½ × 5 ins. For curve records, four pages are used, the edge of the middle leaf being cut off for the width of the first column. A similar arrangement is used for gradients, while the record of tangents covers only two pages.

I can hardly suggest any methods to be followed in all cases, as conditions probably vary in different offices, both as to the extent of work subordinate to that office and the information which it is necessary to send to superior offices. In all cases blanks and forms should be of such a size as to fold to one uniform size for convenience in handling and filing. A uniform classification of all routine track and maintenance work would be proper for purposes of comparison, but I am not prepared to name number and names for such a classification. Such a subdivision of accounts could only be maintained, perhaps, when the work was heavy enough to demand a clerk for the office of maintenance of way, or supervisor's office, as the case might be.

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors, at Joliet, Ill., Jan. 22, 23, 24.

†Engineer of Maintenance of Way; Rio Grande, Sierre Madre & Pacific Ry., El Paso, Tex.

BOOK REVIEWS.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—Proceedings of the Ninth Annual Meeting. Buffalo, N. Y., June 29-July 2, 1901. Edited by Frank O. Marvin, Robert Fletcher, Henry S. Jacoby. New York: Engineering News Publishing Co. Cloth; 6 × 9 ins.; pp. 348. $2.50.

The officers of this society, for 1901-2, are as follows: President, Robert Fletcher, Thayer School of Civil Engineering; Vice-Presidents, Storm Bull, University of Wisconsin, and Calvin M. Woodward, Washington University; Secretary, Henry S. Jacoby, Cornell University; Treasurer, Clarence A. Waldo, Purdue University. The papers contained in this volume are as follows: "The Cultural Value of Engineering Education," Retiring President Frank O. Marvin; "The Arrangement of Electrical Engineering Courses," John P. Jackson; "A Neglected Opportunity in Technical Education," C. F. Burgess; "The Howard Houston Hall, University of Pennsylvania," Henry W. Spangler; "To What Extent Should Modern Languages be Required in Engineering Courses?" Charles L. Crandall; "How the Graduating Thesis Can be Made Most Effective in College Training," Wm. M. Towle; "The Availability of Correspondence Schools as Trade Schools," Dugald C. Jackson; "The Danger of Excessive Specialization in Undergraduate Engineering Courses," James C. Nagle; "The Promotion of Engineering Education and Graduation Requirements," Wm. G. Raymond; "Minimum Requirements for Graduation from a Curriculum of Civil Engineering," Robert Fletcher; "Requirements for Degrees in Engineering Courses," Lingan C. Randolph; "Some Recent Tendencies in Higher Technical Education," John B. Johnson; "Æsthetics in Engineering Design," Russell Sturgis; "To What Extent and in What Direction is it Desirable for a Professor of Engineering to Accept Engineering Employment?" C. Frank Allen; "To What Extent Should Engineering Teachers Engage in Outside Work?" William Kent; "Research and Publication Among Engineering Teachers," Wm. S. Aldrich; Report of Committee on Entrance Requirements; "The Calibration of a Riehle-Gray Apparatus," George R. Chatburn; "Machine Work in an Engineering College," Wm. P. Turner; "Trades' Training for Non-Technically Educated Men," John G. D. Mack; Report of Committee on Statistics of Engineering Education; Memoirs of Deceased Members; Index.

THIRD LIVERPOOL TRIALS OF MOTOR VEHICLES FOR HEAVY TRAFFIC, June 3, 7, 1901.—The Liverpool Self-Propelled Traffic Association. Judges' Report. Edited by E. Shrapnell Smith, Honorary Organizing Secretary, Liverpool, England. Paper; 6 × 9¾ ins.; pp. 176; illustrated. $4.

In our issues of July 18 and Aug. 29, 1901, we gave a general resume of the result of these trials and some description of the vehicles taking part therein. The present official report is very full and detailed in its character; and to it we must refer those particularly interested in what is undoubtedly the most intelligently conducted competitive test of vehicles of this type that has ever taken place. The report separately describes each class of vehicle taking part, and shows the general arrangement and detail of the wagons, their boilers, engines, change-speed gearing, etc. In this competition six of the vehicles were propelled by steam and two by internal combustion engines using petroleum spirits.

In their final conclusions the judges say of the latter that they worked satisfactorily; but their chief drawback was the heavy cost of fuel per ton-mile, as compared with solid fuel for the steam-propelled vehicles. The judges admit that when a speed of 6 to 8 miles an hour, with a load not exceeding 2 tons, is a factor in determining motor power, the higher cost of the fuel may be compensated for; and when internal combustion engines can be adapted to use ordinary mineral oil, without creating a nuisance, their wide adoption is assured. The judges found that in good weather a motor vehicle can average 5 miles per hour on the road; that in 12 hours, leaving 4 hours for meals and the collection and delivery of goods, it can make a journey of 40 miles between terminal points. As to maintenance, it is found that the standardizing of parts has rendered this less difficult than in 1898; improvements in the methods of suspension—like the Coulthard spherical bearing—have reduced the strains and twisting movements. One of the serious factors in the cost of maintenance, however, is the liability on the part of the driver to allow the water to run low in the boilers when climbing long hills, thus damaging joints and tubes. Some automatic arrangement should be devised to meet this. The judges believe that not less than $375 per annum should be allowed for ordinary repairs and adjustments when working 12 hours per day. The machines to which prizes were awarded proved their ability to go anywhere a horse-drawn vehicle could go; and to start and to stop, both up and down hill, on a gradient of 1 in 9 on a paved surface. In descending steep hills the control was such that the normal speed could be maintained without locking a wheel or using a "slipper." In the matter of gearing, the general absence of adequate, dust-proof, oil-retaining casing between the last counter-shaft and the driving axle, or wheels, calls for further consideration on the part of the makers. The driving wheels, while much better than in 1898, still show signs of undue stress under heavy shocks and vibration on rough roads, and some practical means of absorbing these shocks is desirable. The present legal tare limit of 3 tons is still too low when loads above 5 tons are to be dealt with upon a single platform.

The judges finally concluded that several makers are now building motor vehicles upon lines which closely meet the requirements of trade in large manufacturing and distributing centers; that it is now possible to carry loads up to 7 tons, and to haul 3 tons more on a trailer by using vehicles of the class C type tested in 1901. But these requirements will not be fully met until 10 tons can be carried on one platform. Further tests are to be made.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

The Jerome Park Reservoir controversy, as may be seen from the article elsewhere in this issue, has now resolved itself into a virtual change from a unanimous report on the part of the Board of Engineers into an official minority report, and an unofficial majority report, the latter still at variance, as was the original unanimous report, with the opinions of the chief engineer of the work in question. In view of all this, and of the fact that the original plans for this reservoir were made under the direction of so eminent an engineer as Mr. Alphonse Fteley, Past-Pres. Am. Soc. C. E., we renew the suggestion offered in our issue of Jan. 16, that the whole matter be referred to a new board of engineers.

Probably there is no one subject of importance to a large class of engineers on which engineers know so little as asphalt pavement specifications. This may seem an ill-considered statement, and one that is unfair to the profession, but we do not think many engineers will be inclined to challenge it. We believe, therefore, that engineers and municipal officials generally will be surprised to learn that the New York Commissioners of Accounts have had the temerity to submit to Mayor Low a report severely criticising the specifications formerly adopted by the old Department of Highways, and submitting what is virtually a new set of specifications for this class of work. It is true that the commissioners, as will be seen by the report elsewhere in this issue, disclaim personal knowledge of so technical a subject, and throw the whole responsibility for the technic of the specifications upon Mr. Otto H. Klein, who is their Chief Engineer. How the proposed changes are considered by the highway engineers of the several boroughs we cannot state, for they do not appear to have been referred to the borough presidents, under whose jurisdiction the streets now are, and thus have not been reported upon by the highway engineers. Under these circumstances we are unable to lay before our readers the criticisms of such authorities on asphalt paving matters as Messrs. N. P. Lewis and Geo. W. Tillson, M's. Am. Soc. C. E., Engineer and Assistant Engineer, respectively, of the Brooklyn highway department, and Mr. W. H. Broodhurst, Chemist to the same department. We have been fortunate, however, in securing a review of both the old and the proposed new specifications, and of Mr. Klein's severe criticisms of the former, from Mr. A. W. Dow, Inspector of Asphalts and Cements for the District of Columbia. This review will be found immediately after our abstract of the report in question.

Whatever may be the merits or demerits of the changes and criticisms suggested by Mr. Klein, it should be understood that the old specifications, in many of their essential features, are identical with those used by the city of Brooklyn before consolidation. The engineers who drew them were not only retained through the succeeding three years of Mayor Van Wyck's administration, but they are still in office. They are, however, no longer responsible to a general Commissioner of Highways, appointed by the Mayor, but to the President of the Borough of Brooklyn, who, in turn, was elected by a popular vote of the citizens of that borough.

We have taken pains to point out the above facts as a simple act of justice to Messrs. Lewis and Tillson, who have long been honored members of the American Society of Civil Engineers, and who also enjoy the distinction of being, respectively, ex-President and Secretary of the American Society of Municipal Improvements. All this is well enough known to many of our readers, but some, doubtless, did not know that the specifications so ruthlessly criticised by Mr. Klein were largely the work of such well-known authorities on the subject. We trust that this fact was also unknown to Mayor Low, who, we should suppose, would not otherwise have been a party to rushing this report into print two days after it was made, and allowing it to remain for three weeks before the public without giving the Brooklyn officials an opportunity to say a word in their own defense.

As this matter now stands, everyone connected with the old Department of Highways, whether in Brooklyn, Manhattan, or any other borough that let asphalt contracts, is virtually held up to public indignation as members of an alliance between Tammany and the Asphalt Combination to maintain a monopoly and exact monopoly prices from the taxpayers of Greater New York. It is not for a moment to be supposed that this is just and those affected by the virtual accusation thus made to the chief officer of the city should be given an opportunity to state the facts in the case.

Inasmuch as we have said that Messrs. Lewis and Tillson are responsible for many of the chief features of the present specifications, we take pleasure in adding that the old Brooklyn specifications do not include what we consider to be one of the most reprehensible features of the present specifications. We are compelled to add that the Commissioners of Accounts have not only retained this feature, but have actually made it worse than before. We refer to the clauses providing that all prospective bidders must lodge with the authorities samples of the various paving materials and ingredients in advance of the date of receiving bids. The new specifications extend the period from 4 to 14 days. If the commissioners wish to ensure free competition, and to prevent the exclusion of bidders whom some official might, perchance, look upon with disfavor, why not find some means for lodging samples which will not disclose long in advance every prospective bidder.

In concluding our comments on the report we wish to state plainly that we have no doubt but that asphalt pavement contract-lettings in Greater New York are in need of reform. We are only urging that the reforms be made with justice and courtesy to the various officials involved, and with assurances from disinterested engineers and chemists that the measures proposed will actually effect the desired end.

THE STEAM MOTOR CAR; CAN IT BE MADE A SUCCESS?

We record in another column some experiments undertaken a few years ago with steam motor cars for railway service, the results of which were disappointing to their promoters, but which are nevertheless of much interest and importance, and deserve to be brought to the attention of engineers and railway managers.

The public has heard a great deal about the substitution of the electric motor for the locomotive on various lines of suburban railway, and of the great economies which have resulted; but the real reason for these economies is very commonly misunderstood. The mere question of the comparative cost of the electric current and of the steam power delivered at the driving wheels is of little importance. There may be a saving or there may be a loss by the substitution of electricity, but the difference will not be great. What really counts is the difference in the cost of train service between the locomotive-operated road and the electric railway. In the one case we have on every train an engineer, fireman, conductor and brakeman, and perhaps a baggageman as well, all of them receiving wages which are influenced largely by the traditions of steam railroading. In the other case we have a motorman and a conductor, receiving wages which are fixed by tradition, dating from the days of horse-car service. We do not need to present figures. The contrast is evident enough without them.

Again, this high cost of train service on a steam road compels train service to be kept down, especially on lines of thin traffic; and the infrequent trains cause passengers to take competing electric car lines in preference. Reasons like these are the real explanation why the electric motor is able to beat the locomotive in competing for suburban traffic.

The electric traction system, however, has troubles of its own, which closely limit its scope in dealing with the operation of long lines with light traffic. It requires the equipment of a power house, with capacity enough to take care of the maximum traffic on the line; it requires the erection of overhead trolley wire or the laying of a third rail, together with the bonding of the track rails and the stringing of feeders. All these things mean so large an investment as to absolutely debar electricity from consideration on a very large class of American railways.

On the other hand, it is undoubtedly the case that on a very large proportion of the American railway mileage, passenger traffic is carried on at an absolute loss. We have only to turn to the statistics of the Interstate Commerce Commission to make this fact entirely clear. The average number of passengers per train in the whole United States in the year ending June 30, 1900, was only 41. If we take out of this total the through trains, and the heavily loaded suburban trains, all the trains, in fact, in which the locomotive is given its full work to do, it will be evident at once that on at least half of the railway mileage of the United States and for at least half the trains operated on the remaining mileage, the work is being done in a most expensive and wasteful manner. To set a locomotive of 500 to 800 HP. to the work of hauling an average of perhaps 20 passengers, is like taking a steam hammer to crack a filbert.

There is a fortune awaiting the engineer or the manufacturer who will develop and place upon the market a thoroughly practical and satisfactory independent motor car, which can be run as electric cars are run, but without the drawbacks inherent in the electric system.

Is the task impossible? We do not see why it should be. The motor vehicle inventors and manufacturers have produced machines which are operated with fair success over common roads with all sorts of grades and rough surfaces. Surely the operation of a car over smooth rails is a far less difficult problem. The "chauffeur" of an automobile has to constantly steer his machine. The driver of a car running on a track is freed from this necessity.

For the motive power of such a motor car we have little faith in anything but steam. The storage battery has been tried again and again and

again during the past dozen years, and in every instance it has been found wanting and discarded. Besides all its other faults, it is of necessity costly to establish and costly to maintain. Its radius of action is very small, and cars equipped with it are in reality closely tethered to the power stations. The last-named objection applies also to the compressed air car, of which so much has been heard in the way of promise and so little given in the way of performance. It applies with even greater force to the various types of "stored steam," or superheated water motors.

The fact is that on any railway line short enough to permit the use of any of these systems, the electric trolley system is available and is pretty sure to come off victor in the competition.

There remains, indeed, one possible competitor of steam—the internal combustion motor, which has already scored a large degree of success in the automobile field. It is quite within the field of possibilities that a gasoline or petroleum motor car may yet be developed which will in large measure fulfil the requirements of the traffic we are considering. One great advantage of such a system, of course, would be the dispensing with the boiler. We incline to the belief, however, that this gain would be more than offset by the difficulty in starting with such a system. It is exceedingly important to the success of any independent motor car that it should be capable of prompt starting from a stop and rapid acceleration. We fear this is an impossibility with any form of internal combustion motor.

Turning now to the steam motor cars, which are described in this issue, it ought not to be difficult, we think, to see reasons for their failure to achieve a practical success, besides the numerous faults of detail which are described in the article itself. The fact is, as was tersely put by one of the officers of the Baldwin locomotive works, that the motor was designed too much on the lines of ordinary locomotive construction. The cars had too much dead weight, required too much power and were built to attain too high speed, and with too great a hauling capacity to be successful. Too much engine requires too much boiler, and this in turn caused trouble with the firing and difficulty with vibration, with water and fuel supply, with condensation and what not.

We believe that the road to success with a steam motor car will be found by copying electric car construction and placing speed-reducing gears between the engine and the driving axle. By doing this a much smaller and lighter engine will give better starting power and acceleration and ability to climb steeper grades than can be obtained with the engine working directly on the driving axle. At the same time limitations on the size of wheels are overcome and the economy of steam in the cylinder is improved. It is true that such high speeds are not possible with this system; but we maintain that for the service for which motor cars are needed high speeds are not essential or desirable. Few electric cars exceed a speed of 25 to 30 miles per hour, and the same thing is true of the trains drawn by locomotives on many thousand miles of American railways. We do not say or think that higher speeds than this are not practicable with steam motor cars; but it is not wise to attempt them or specify them at the outset. We are told that one of the cars which has proved a failure was capable of a speed of 60 miles an hour, and of hauling 11 freight cars in switching yards. It is hardly strange that such a car did not prove an altogether comfortable vehicle for passenger transportation. If its designer had not attempted to combine a switching locomotive with a passenger car he might have been more successful.

A second and very important feature in the design of a successful steam motor car will be the boiler and the system of firing employed. It is absolutely essential to dispense with the fireman and to make the task of attending the fire so easy that the engineer can do whatever is necessary without interfering with his necessary attention to other duties.

It will be instructive at this point to turn for a moment to the steam automobile. Five years ago —or ten years ago at most—no such thing as a steam vehicle for use on common roads was in existence. Now they are numbered by tens of thousands. As machines they embody no new mechanical principle, and there is no skill or mechanical design in their construction that was not just as existent ten years ago as to-day. What one particular feature suddenly made the steam motor vehicle a practical success instead of a practical failure, as every previous machine of the type had been? We believe the answer to this question is the automatic apparatus for firing the boiler. No road vehicle could be a success so long as the driver had to give attention to the fires as well as to his steering lever and his engine. A bright inventor made a burner to use an ideal smokeless fuel of high-heating power (gasoline), and provided an automatic attachment to control the flow of gasoline by the variation in steam pressure. That made the steam motor wagon a success.

Now, some similar happy thought is needed to make the steam motor car a success. The designers of the steam cars illustrated in this issue tried to do it and failed—partly, as we have just pointed out, because they tried to make too big a machine. It is not at all impossible that the road out of the difficulty may be found through the use of the fuel oil, for which the owners of Texas oil wells are now so anxious to find a market. Obviously, oil is a vastly easier fuel to handle and control automatically than any kind of coal, and it is not impossible that the Texas oil discoveries may yet prove the key to the difficulties in the way of designing a successful motor car.

We do not mean to indicate by this suggestion that an automatic system using solid fuel is impossible. On the contrary, the very fair success attained by some of the steam motor trucks which burn coal or coke, and are designed to haul heavy loads over common roads, gives much encouragement to those who would design a steam motor car on these lines. It may be pointed out, too, that absolutely automatic firing is by no means so essential in a steam car designed to run on a track as it is in a steam vehicle to run on common roads, where the steering requires constant attention. The engineer of a steam motor car can give considerable attention to firing provided the fire can await his convenience, and does not require attention just at a time when other duties are imperative.

The design of the boiler is evidently a most important factor. The ordinary locomotive type is almost ruled out by its length and by the very small margin in depth of water over the crown sheet. On any such machine as is here proposed, the engineer ought not to be required to watch his water-gage constantly to guard against a boiler explosion. The vertical boiler is excellent from this point of view, but is difficult to clean, and likely to give trouble by leaky tubes. Either a miniature Scotch boiler or some form of water-tube boiler would appear to give the best promise of success.

We might continue to discuss other details of design, but those already enumerated are by all odds the most important.

In conclusion, we wish to call attention to the enormous field which the development of a successful steam motor car would open for the construction of cheap railway lines. There are thousands of places in this country where a profitable traffic can be furnished to railways which can be built at a total cost of not more than $5,000 to $10,000 per mile, and operated by some such cheap and cheaply-operated form of motive power as we have discussed.

LETTERS TO THE EDITOR.

Short Cuts for Flat Right Triangles

Sir: The problem presented by Mr. J. A. Ray, C. E., in Engineering News of Jan. 16, 1902, concerning the difference between the hypothenuse and long side of a flat right triangle, may be very easily solved by the following rule with which some of your readers may not be familiar: the square of the short side divided by twice a long side equals the difference of the two long sides, or

$$x - y = \frac{x^2}{2y \text{ or } 2z}, \text{ nearly.}$$

When x is not more than 1-10 of z and z is 1,000 ft., the maximum error in this formula is 0.01256 ft. When x is 20 and y is 100, z is 101.9804 while the formula gives 102.0. These examples show the possibilities of the formula and one can easily decide whether its accuracy is sufficient for any particular problem.

Yours very truly, John P. Brooks.

Lexington, Ky., Jan. 22, 1902.

Relining Railway Curves.

Sir: The article on this subject in your issue of Dec. 26, 1901, contains many interesting points, which, if carried out, would be appreciated by both trackmen and engineers. Having used an efficient and rapid method for relining curves during the past summer, a brief account may be of interest to those who have charge of such work. There can be no claim to originality, as this method has doubtless been used by other engineers, though suggestions for such work are seldom given in our field books and periodicals.

On this road the "Searles" spiral is used on all but very easy curves. The terms S and S' denote the spiral points, while B C and E C are retained to designate the ends of the simple curve between the spirals. By the ordinary method the simple curve is located with the instrument at the B C and taking back sight at S. To avoid the probable error in alinement due to such a short back sight, locate the points B C, E C, and the center G. With the instrument at G and vernier at zero, sighting to B C, the deflection to the E C can be readily checked, and the entire curve, if short, can be run in at this one set-up. However, this method of using the center point G most commends itself in cases of very long, light curves with short spirals, and with B C and E C not visible from G. At the time that G is located from F, set also a point H or H' in this same line and distant several hundred feet therefrom. Move the instrument to G, set the vernier at 90°, minus the deflection angle to G, and sight on H. When the vernier is then set to zero the sight will be to the B C. Hence the curve can be run either way from G, using the ordinary deflection angles figured from the B C. If H or H' cannot be easily set, the point D or an offset therefrom, equal and parallel to F G, can often be conveniently used.

My usual back sight is a tooth-pick or small stick, behind which is placed a piece of coal, readily found along most of our tracks. Small tins, punched "S., B. C. 2¼°," etc., are nailed at the ends of ties opposite the respective points in the curve. Very truly,

L. E. Ashbaugh.

C. M. & St. P. Ry., Minneapolis, Minn., Jan. 4, 1902.

Forming Foundations in Sand or Gravel by Injecting Cement Grout.

Sir: In your issue of Jan. 9, 1902, there is a very interesting description of the erection of a three-hinged concrete arch bridge over the Danube River at Ehingen, in which great stress is laid upon the method of founding the piers by injecting cement grout into the gravel formation. A foot-note also states that similar methods were used on two other Danube bridges in Bavaria in 1898 and 1900, respectively.

The same method was used by an American engineer at an earlier date in one instance at least. Mr. Miller A. Smith, M. Am. Soc. C. E., while chief engineer and general manager of the Guatemala Northern Ry., in 1896 used practically the same process in founding some cylinder piers for a narrow-gage railway bridge across the Zacapa River at Zacapa, Guatemala, Central America. The bridge mentioned consisted of three 120-ft. through truss spans, and was carried on stone abutments and cylinder piers consisting of pairs of 5-ft. steel cylinders filled with Portland cement concrete. The writer, as principal assistant engineer, was in general charge of construction and the bridge work was under the immediate supervision of Mr. J. M. Dixon as assistant engineer. The Zacapa River is a mountain stream with a fall of 15 to 20 ft. per mile at the point where the bridge is located. After a heavy rainfall in June, 1897, the water reached to within 18 ins. of the top of cylinders without any resulting damage to the foundations by scouring.

Respectfully, J. T. Norton, M. Am. Soc. C. E.

Vicksburg, Miss., Jan. 23, 1902.

(In Engineering News of March 14, 1891, was published an abstract of a paper read by the late Robert L. Harris, M. Am. Soc. C. E., before the American Society of Civil Engineers, describing substantially this method of foundation work. A further development of Mr. Harris' method for use in quicksand, in which water under pressure is used to wash out channels in the sand before the grout is injected, was described in Engineering News of April 28, 1892.—Ed.)

Approximate Formulas for Finding the Area of a Circular Segment.

Sir: In solving problems where the areas of segments are to be found, the ordinary method of obtaining the area of the sector and adding or subtracting the area of the triangle, is inconveniently long in the majority of cases. I have deduced an empirical formula for the area of a seg-

ment which I have used to advantage many times, when the height of segment and diameter of circle are given or can be found readily.

Let d = diameter of circle, and h = height of segment. Then for values of

$$h \text{ from } 0 \text{ to } \tfrac{1}{4}\,d;\ \text{area} = h\sqrt{1.766\,d\,h - h^2};$$

$$h \text{ from } \tfrac{1}{4}\,d \text{ to } \tfrac{1}{2}\,d;\ \text{area} = h\sqrt{0.017\,d^2 + 1.7\,d\,h - h^2}.$$

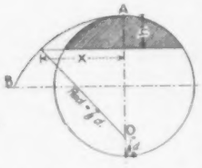
This is shorter and more accurate than any other approximate formula of the kind I have been able to find in any of the commonly used handbooks. It also avoids the use of trigonometric tables. Its very small per cent. of error is shown by the following table which gives the percentage of error for different heights of segment. To obtain results as close by the ordinary method, requires a table of natural sines reading in the seconds, and carrying the computation through with a long decimal fraction. Using a diameter of 10 with different values of h:

h = h't seg.	Formula—Approximate.	Exact.	Difference.	Error.
0.01	0.004	0.004	.....	....
0.05	0.047	0.047	.....	....
0.1	0.1325	0.1327	0.0002	— 0.15%
0.5	1.465	1.468	0.003	— 0.20%
1	4.082	4.087	0.005	— 0.12%
1.5	7.385	7.387	0.002	— 0.03%
2	11.193	11.182	0.011	+ 0.10%
2.5	15.391	15.355	0.036	+ 0.23%
3	19.832	19.817	0.015	+ 0.08%
3.5	24.487	24.498	0.011	— 0.05%
4	29.312	29.337	0.025	— 0.09%
4.5	34.256	34.278	0.022	— 0.06%
5	39.275	39.270	0.005	+ 0.01%

A convenient graphical method for determining the area of the segment is carried out as follows:

In the annexed sketch, let

d = diameter of circle;
h = height of segment in question.



Take a radius equal to ⅝ d, and with a center O on a diameter of the circle perpendicular to the chord of the segment at its middle point, and distant ⅜ d from the top of the segment A, strike an arc B A, which will be tangent to the curved side of the segment at its middle point A. Produce the chord of the segment to intersect this arc, and call x the distance from this intersection to middle point of the segment. Scale the distance x; then h x equals the desired area of the segment. Yours truly,

Wm. F. Martin,

Scherzer Rolling Lift Bridge Co., 1616 Monadnock Block, Chicago, Jan. 1, 1902.

Place the Isthmian Canal Work in Charge of an Engineering Commission.

Sir: The subject of the formation of a commission which shall control the construction of an Isthmian Canal seems to have awakened general interest among engineers, and several articles have already appeared in your columns in regard to it. The communication of Mr. J. F. Wallace was a step in the right direction, while that of Mr. S. Whinery seems to me to be a very near approach to a solution of the subject. After reading Mr. Wallace's article it was my intention to reply to it, using practically the same arguments that Mr. Whinery has advanced; but circumstances prevented, and so some of my ideas have been anticipated. However, that does not prevent further discussion, and I request the privilege of making a few brief remarks on the subject.

Since this great undertaking will be strictly and entirely of an engineering character, I think the commission should be composed entirely of engineers. It should be composed of nine members, which would, as Mr. Whinery suggests, prevent a tie vote. My suggestion as to its composition is as follows:

From the Engineer Corps, U. S. A.	2
From the U. S. N. (officers educated as civil engineers).	2
From the civil engineers	5
Total	9

As the proposed canal would eventually be entirely under government control, it would seem better to have the government represented by officers of the army and navy, as these departments would, in the event of war, have more to do with the canal than any other class of people, and it would therefore seem proper to have the government amply represented during construction.

I do not agree entirely with Mr. Whinery in regard to appointing three members from citizens of business or executive capacity, and one from the profession of law. There are many engineers of national reputation in this country who combine both business and executive capacity with engineering ability, and I think that the greater the number of expert engineers that could be appointed members of the commission, the better it would be. Any amount of the ablest legal talent and also any number of able citizens could be employed by the commission, either permanently or temporarily, which would leave a greater number of vacancies to be filled by the appointment of eminent engineers as members.

It should also be understood that the U. S. Army and Navy officers would not, while members of the commission, be governed entirely by the "red tape" rules and regulations under which they generally perform their duties, but that they would be allowed to exercise their individual judgment, and express their individual opinions the same as, and in conjunction with, the civilian members of the commission. Then after the completion of the canal they could return to their rules and regulations with full and complete knowledge of the canal from start to finish which would prove of inestimable value to the government in times of both peace and war.

I think Mr. Whinery's idea, in regard to individual members of the engineering profession making suggestions along these lines to members of Congress from their districts, is a very good one, and should be given due consideration. Yours truly,

H. F. Wilson, Jr.

315 Chalifoux Building, Birmingham, Ala., Jan. 30, 1902.

Did the Contractor Build the Dam Up Side Down?

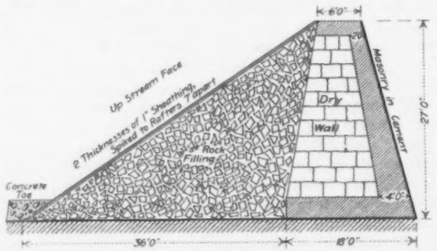
Sir: With regard to the dam section accompanying Mr. John C. Temple's communication in your issue of Jan. 16, it would seem that there must be some confusion, either on the part of Mr. Temple or that of his informant, as to the proper placing of this section in the stream. Of course, it is possible, though hardly probable, that the designer intended it to be set in one position, while the contractors built it in the reverse. However that may be, the section would under certain conditions serve quite well with the masonry-in-concrete on the up-stream face. In the reverse position, as Mr. Temple gives it, the dam would be scarcely better than a pile of so much loose rock.

It would be instructive, as well as interesting, to hear from the designer of the section in question as to which position it was intended by him to occupy. It is incredible that it was designed to be built as Mr. Temple states.

Yours truly, Thos. R. Weymouth.

New York, Jan. 21, 1902.

(In order to settle once for all the question whether this dam was in some mysterious manner built wrong-side-to we made inquiries which led us to believe that it was located near Athens, Ga., and probably owned by the Athens Electric Railway Co. This supposition was confirmed by Mr. J. W. Barnett, City Engineer of Athens, Ga., who referred our inquiry to Mr. C. D. Flanigen, General Manager of the company named. Mr. Flanigen has sent us the very interesting letter printed below, from which it appears that the South, rather than the Far West, may have been



An Example of Dam Construction in the South.

(Repeated from our issue of Jan. 16.)

the pioneer in rock-fill dam construction. Mr. Barnett states that the dam in question is about nine miles from Athens. For the convenience of our readers we reprint the section of the dam in question. We also call attention to the lawyer-built dam described and illustrated by another correspondent in the letter by "Mem. Am. Soc. C. E.," which immediately follows this one. If the lawyer can defend his design as ably as Mr. Flanigen has supported the structure at Athens, we shall be glad to hear from him, also, but we must confess ignorance as to his whereabouts.—Ed.)

Sir: Referring to a communication from Mr. John C. Temple, in your issue of Jan. 16, containing incidentally a criticism of "An Example of Dam Construction in the South," we beg to say that the cut represents closely a dam now being constructed by this company on the Middle Oconee River with this material difference, however. The masonry-in-cement, instead of being on the down-river face of the dam is on the bed of the river as a base for the dry wall. The down-river face has 1 ft. of what might be called masonry-in-cement, the only purpose of which is to obtain a thorough pointing of this face to present a smooth surface to the falling water.

It is not designed to hold water coming through the sheathing, and that it will not do so has already been demonstrated in the recent freshet which resulted so disastrously to the dams at Portman Shoals, S. C.; Tallassee, Ala.; Columbus, Ga., and other masonry-in-cement dams.

How much of the water that came through in many little streams leaked through the sheathing and how much through the incomplete open end, with its 12-ft. wall of rushing water, it is impossible to say. This freshet was the greatest on this river since 1887, and that year was the record since 1845, and yet less than 100 cu. yds. of the ragged unfinished end of the "pile of loose rocks" was carried out, as the water, 12 to 14 ft. deep, tore through the 100-ft. opening between the east pier and the incomplete dam.

Further than this, the 8-ft. false dam 100 ft. long, which was designed to turn the water from the gap under construction, was built in this same shape, with posts of 6-in. pine 4 ft. apart, spiked to a piled mud sill, and covered with 1-in. sheathing. This light dam, when the flood was at its highest, was covered with water 12 to 13 ft. deep at the mud sill, or 4 or 5 ft. on the crest, but remained intact until the day after the waters had subsided and then gave way, the contractor ascribing the break down to the weight of the sand left by the receding flood. The mud sill and piling remained uninjured and only a short time was required to reconstruct it.

In dams of this character, the mud sill is one of the most important features, forming the toe of the dam. It is pinned down to the solid bed of the rock and thoroughly braced. It is double-piled and protected and supported by masonry where there are inequalities in the rock. After the rock filling has been completed, the rafters, on 3-ft. centers, are securely pinned to the mud sill, and to a bond timber at the top of the slope, and double sheathing laid across the direction of the flow of the river.

The Athens Electric Railway Co., six years ago, built at its present station a timber dam of this cross-section 10 ft. high at one end and 15 ft. at the other, 400 ft. long, single sheathed with 1½-in. rough pine boards. This dam was faced and filled with rocks two years ago, but previous to this, a representative of the International Hydraulic Co. could have viewed the impossible, inasmuch as he could have walked from one end to the other underneath the sheathing without injuring in the slightest his best silk hat. Such a result as this is not always obtained, requiring some little care, and it called forth from an old cotton-mill man the comment: "That is what I call a jug-tight dam!"

As a matter of fact, however, in southern waters and, as one of your correspondents suggests, this may not apply to the clear waters of many of the northern rivers, it is the exception and not the rule when these dams, built of rock, leak to any great extent. After a few years the "pile of loose rock," for this is what it might actually be called, protected by a mud sill, piling, sheathing, and a laid-up face in the down-stream side, becomes practically a solid mass of rock, sand, and soil which is as difficult to tear up as an ordinary macadam road.

Dams of this design have been built in this section for years and are well illustrated by one in the service of the Georgia Manufacturing Co., five miles from this city, which was first constructed prior to 1825, and 20 years ago had 2 ft. in height added to it; aside from this, not one dollar has been spent upon it and its record is only that of others of similar construction, and we know of none that has been washed out.

Therefore, if the objection to design of the dam as published is not caused by the mortar-in-cement, to which wrong motives were imputed, it seems strange to us that they should be so unanimously condemned by your able correspondents with such evident commiseration for those in a position similar to that of the old gentleman, long since gone to his reward, who years ago purchased one of these structures which serves a cotton mill that made him wealthy and is now operated in the interest of his children, his grandchildren, and his great grandchildren. It has stood the storms and freshets of nearly a century and is apparently as good to-day as it was the day of its completion, and, in all probability is stronger, as it is a part of the bed of the river, with sand, rocks, sunken logs and other debris piled on its mud sill and slope to a height equal to three-fourths of the total height of the dam.

We have advanced no theory why these dams should remain in stable equilibrium; we have stated the facts as they exist and leave it to those more capable than we are to work out the why and the wherefore, should the problem be interesting to them. Yours truly,

Athens Electric Railway Co.,
Per C. D. Flanigen, Gen. Mgr.

Athens, Ga., Jan. 27, 1902.

The Masonry of the Upper Tallapoosa River Dam; How a Lawyer Built a Dam.

Sir: After noting the doubts of Mr. John C. Temple, in your issue of Jan. 16, about the character of masonry in the Upper Tallapoosa Dam, and your remark in the issue of Jan. 23, advocating Cyclopean rubble in concrete, I think a view of the result of the method of the International Hydraulic Co. in building the interior of their dam will be of use. At least, it gives at a glance what would require columns of descriptive matter.

The view, Fig. 1, shows a cross-section of the dam near

the middle of the stream and is in the portion still standing. The man in the view is about 5 ft. 7 ins. tall, which gives one a fair idea of the size of the stone.

As the "bed of the foundation" was patiently washed with a hose and scrubbed with brooms, and as each stone was swung clear and all dirt and dust washed off with hose before laying, and as many of the so-called "spalls" were about one-man stone (some shown in the view) and as the masons were mostly "imported," it is hard to see what Mr. Temple finds to criticize. One look at the size of stone and "spalls" should convince anyone that the modest claim of the company for 10% additional weight per cubic yard is well founded.

Fig. 1. Masonry of the Upper Tallapoosa Dam.

Still, this dam went out. As a contrast to the above, there is a dam designed by a lawyer which is still standing. The cross-section is as given by Fig. 2, and the following data concerning its design and erection are strictly true. The arguments are almost literal.

This lawyer had once received a $10,000 fee (not for hydraulic engineering) and looked upon the design of a dam as an incident in the "case" of improving a tract of land. He could not remember exactly what book he borrowed, but thought it was Trautwine. On being asked why the inclined side was up-stream, he replied that the book advocated it. A lawyer is nothing if not logical, and a glance into Trautwine showed that of seven timber dams shown by cuts, four of them were of triangular cross-section and inclined up-stream. That made a preponderance of evidence in favor of that form. As knee braces are properly placed at an angle of 45°, a batter of 1 on 1 was decided upon. Again, as masonry is more rigid and stronger than timber and all cement tests were by "pull," instructions to use plenty of Louisville cement 1 to 2 gave the masonry all the tensile strength necessary and "masonry lasts longer than timber."

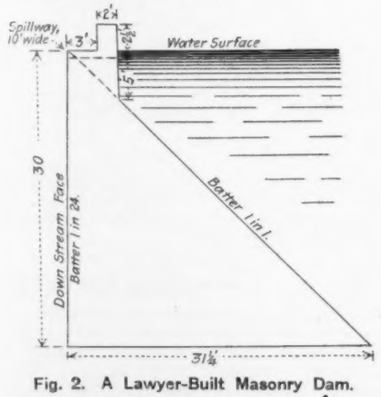


Fig. 2. A Lawyer-Built Masonry Dam.

A "stone chimney" mason was employed as superintendent and skilled mechanic at about $1.50 per day, a double team and wagon with driver at same price, and a number of "renters" who had crops "laid by" were secured at 60 to 75 cts. per day.

The site was pretty well cleaned down to solid rock, and large surface rock slid into place from the near hillsides. Then the wagon came into play. All the fields in the vicinity furnished one-man stone in abundance and were contributed gratis by the owners. This saved the item of quarrying. A float was built to hold a couple of wagon loads of stone and the stone was laid as fast as the "lake" (of about 70 acres) rose. As a precaution against "floods" pipes were laid through the dam at varying heights, with diameters from 12 to 4 ins., and with valves on the down-stream side. The spillway was 10 ft. wide and about 6 ins. deep. The parapet was added to prevent cutting around the abutments (about 200 ft. apart) and for "looks." The faces were plentifully plastered with cement mortar as the chimneys in that section usually are. Result: One small percolation leak at the rock surface and a few similar ones at various points.

Some "cracker" millers had the temerity to suggest damage to their property below in case the "dam" thing broke. The New York lawyer with the big fee soon bluffed them out on the "absolute" safety of any of his "constructions," legal or otherwise. The floods since that date, 1892, apparently prove the wisdom of the lawyer and the "cussedness of inanimate things."

Mem. Am. Soc. C. E.

New York, Jan. 29, 1902.

The Comparative Value of Flushed and Grouted Masonry Joints for Dams and Other Structures.

Sir: Regarding the discussion as to the merits of grouted masonry backing versus flush mortar joints, in the Engineering News for Jan. 16 and 23, it would seem that engineers must agree that flushed joints are to be preferred over grouting, as it has been the experience of others, as well as of the writer, that when grout sufficiently thin to flow into horizontal joints is used, there is always danger that the sand in it will settle before the cement has set. In such a case the joints may be all filled, it is true, but is it quite safe to assume that a good cement bond has been uniformly obtained between the stones? The writer has put in masonry backing in bridge piers and abutments on the Louisville Southern R. R. and in the foundation walls of the Edison Building, in Philadelphia, by partially filling the cavities with cement mortar, a trifle thinner than that used by the masons in their regular work, and then working the backing stones down into this, putting the larger stones in first and then forcing smaller ones into each and every interstice, causing each stone to be literally bedded in mortar, and he thinks that a first-class job resulted. In the case of the Edison Building this was demonstrated to be a fact, as it became necessary at one time to remove a part of the wall and it was found that every joint, horizontal, vertical and diagonal, had been perfectly filled and that no voids existed. The writer heartily concurs with the suggestion of the editor of Engineering News that it would be well to make a backing of large stones bedded in concrete, for, during the construction of the Edison Building, the foundation floor of which was a block of concrete over 6 ft. in thickness, test blocks of concrete, about 1 × 1 × 4 ft., were made from time to time and in some of these, in addition to the regular stone of the concrete mixture, were put spalls of hard limestone, each of these being about half as large as a man's head. These test blocks were broken, with wedges and feathers, and in all cases, except where the plane of fracture was just at the edge of a spall, there was a clean fracture through cementing material and imbedded stones impartially, showing a perfect bond between stone and cement. It may be that a "funny" mason will "skin" a flushed joint when the back of the inspector is turned, but will he not do the same with a grouted joint? It may be true, generally speaking, that the "efficiency" of a stone mason is not above 50%, and that means that there must be constant and careful inspection of his work whether he be laying flushed or grouted joints; he will skin the latter class of work as quickly as he will the former and nothing will be gained by grouting if it is to be left to the mason without an inspector "right on top of him" all the time. Yours truly,

Arch. R. Eldridge, M. Am. Soc. C. E.

Chicago, Ill., Jan. 27, 1902.

(Some opinions on this subject are given by Mr. B. H. Hardaway, in an article on "Recent Failures of Southern Dams," elsewhere in this issue. We should be glad to hear from others on this subject.—Ed.)

Concerning the Reliability of Workmen.—A Lay Sermon Based on Grouting the Tallapoosa Dam.

Sir: In your issue of Jan. 23, Mr. John W. Hays, M. Am. Soc. C. E., says in a letter discussing the grouting of the Tallapoosa Dam:

> There may be conscientious stonelayers who will do honest work and make an effort to flush joints when the inspector's eye is turned, but I have never made their acquaintance. . . . I would travel miles to see the stonelayer who would lay a wall flush with dry mortar in the absence of the inspector. . . . The efficiency of a carpenter is about 90%, a bricklayer's 75%, while a stonelayer's is not over 50%.

No matter whether Mr. Hays is writing in semi-earnestness or not, when he argues that a form of engineering construction developed as standard by long practice should be changed because it has become impossible to find trustworthy men of the particular calling required to build these structures, this letter gives the writer a text, or a pretext, for a sermon that he has long wanted to preach, at least to the younger members of his profession, and he will now proceed to preach it, though it be to empty pews.

The writer has spent nearly half of the time since his graduation 21 years ago as a teacher in engineering colleges, and a little more than half in railroad engineering practice. He has had, too, some experience in conducting work with different classes of labor and men in different portions of the country. He has built masonry structures in Mexico with peons, in the south with negroes and "poor whites," and in the middle west with the "natives" and with Irishmen, Scotchmen and negroes. He has had under his charge many of these classes of men in survey parties, and in all the trades and kinds of contractors required in maintenance of way and in heavy railway and bridge construction. One of these bridges, it happens, was over the Coosa River, the twin sister of the Tallapoosa, and not over 70 miles from the Tallapoosa dam in question.

And the writer fails to recall a single instance of any important work he has ever had in hand requiring the imposing of responsibility upon those doing the work, where men, *properly treated and instructed*, did not develop so as to become absolutely trustworthy in every respect in regard to the conduct of their work.

The writer, without any effort of memory, can cite the names and addresses of at least three men of the particular calling most stigmatized by Mr. Hays whose word and work, so far as integrity is concerned, can be trusted alongside of Mr. Hays' own.

The writer does not believe that the trustworthiness or efficiency of the men in any trade or calling can be expressed in relative percentages as Mr. Hays attempts to do, for he knows in his own experience he has found men of all trades and callings with which he has had to do in whom those qualities varied all the way from zero to 100%. And he can cite instances where, for the purpose in hand at least, by fair treatment, and where responsibility was judiciously imposed, trustworthiness was elevated from zero to 100%. Further, the writer is glad to record the fact that he has found the trustworthy man well distributed among all trades, colors and callings with which he has had to do, to the exclusion of none.

No greater injury can be done to the younger members of the engineering profession (who, by the way, read the columns of such papers as Engineering News, more closely than the more experienced members) than leading them to believe that men of certain trades or occupations, such as contractors, locomotive engineers, trainmen, stone masons, etc., are wholly unreliable. Such teachings are responsible for the placing of so many young engineers in charge of work with the idea that they are set there as spies to watch for dishonest practices, to pick flaws and report. The writer can recall instances where he has seen a contractor, honestly striving to do good work, and driven nearly to distraction, and even to complete financial failure, by some little suspicious, flaw-picking inspector who insisted on holding the work down to within a thousandth of an inch of the letter (though not the spirit) of specifications that specified all too much for the good of the work.

The young engineer should rather believe that his duties are to help the work forward and to give instructions to men more ignorant than himself in the best ways of doing things. And these instructions should always be imparted with the quiet courtesy which presupposes that the men under him only need to be shown how in order to do their work honestly. It will be rarely that some, if not all, of the men will not respond to the trust thus imposed. The writer knows that this can be done by an engineer in a tactful way which will win the confidence of the men and yet will not impart the idea that he is a "softy" to be easily gulled.

Men are but grown-up boys. Who of us cannot remember the delight of a schoolboy in securing the "forbidden information" in an examination under a teacher who was vigilant in his endeavors to catch up with the culprits, and how the same boys would bind themselves to do no cribbing under Professor ——— "because he trusts us and treats us like gentlemen."

The writer cannot forbear suggesting to Mr. Hays that perhaps he has not tried this latter experiment with his masons.

The writer does not seek to impart the idea that a kind of a Sunday School Golden Rule air can be thrown successfully around engineering work. But he does believe that the principle that trusting begets trustworthiness lies at the basis of the organizing power that has enabled every really successful engineer to carry out his work; and he sincerely believes that the young engineer who acts out in his practice the belief that his fellow men in the humbler walks of life can never be trusted will rarely rise above the "inspectorship," where he will do a comparatively small amount of injury only because his sphere of influence is so limited.

W. D. Taylor, M. Am. Soc. C. E.,
Professor of Railway Engineering.

University of Wisconsin, Madison, Wis., Jan. 27, 1902.

Sir: Professor Taylor has kindly sent me a copy of his letter bearing on the subject of grouting in dam construction, in which he takes issue with me as to the efficiency of stonelayers. I note that after working for many years in the South and other portions of the country he is able to recall three reliable stone masons. One honest man was found in Sodom and Gomorrah.

Yours truly, John W. Hays.

Petersburg, Va., Jan. 30, 1902.

Notes and Queries.

T. St. P. writes us as follows:

A blacksmith told me, in explanation of the bad results he had had in a certain job of tempering drills, that he thought someone had with malicious intent put soap in the water in which the drills were tempered, thus making the metal very brittle. What effect would the addition of soap to the water have on the drills, and if any, what is the explanation of it?

E. E. H., Boston, Mass., writes:

Can you give me any data or references to data in regard to the probable life of steel structures?

Inasmuch as the use of steel as a structural material has been common only during the past fifteen to twenty years and since many of the earliest steel structures have been replaced because increased loads demanded a heavier structure, direct statements as to the ultimate life of steel structures can hardly be made. We know, however, that the life of steel when not overloaded is fixed only by the progress of corrosion. The life of a steel structure will be determined then by the influences tending toward corrosion and those tending to retard it. Steel exposed to sea water, to continuous moisture, to sulphurous gases, or to any other corrosive agency will have a very short life. On the other hand steel protected from the weather, especially where such protection takes the form of embedding in cement or concrete will in all probability endure as long as its protecting covering.

L. F. B. writes: "At the Brooklyn Navy Yard there are many piles 30 to 50 years old and perfectly sound which were cut off only 6 ins. below high-water mark. None have been cut off below low-water mark."

Our attention has been called by Mr. B. H. Hardaway, of Columbus, Ga., to an error in our issue of Jan. 9, in the article on "Failure of Dams Near Anderson, S. C., and at Columbus, Ga." The dam at Anderson originally had flash boards. Its height was subsequently increased and the flash boards omitted. Mr. Hardaway telegraphed us, after the article was in type, to the effect that the old dam had successfully stood 6 ft. of water on the spillway on the top of 4 ft. of flash boards and that the new dam gave way under a depth of 7 ft. 6 ins. on the spillway. In making corrections on the proof the telegram was misinterpreted so we stated that:

The original section has stood rises of 6 ft. on top of 7 ft. of wooden flash boards. The failure occurred under a depth of 6 ft. on 4 ft. of flash boards.

THE MEXICAN NATIONAL RAILWAY is being converted into a standard gage railway throughout the entire system. Mr. Philip C. Hanna, U. S. Consul at Monterey, says that the National will shortly build a line from Monterey to Brownsville, Tex., and he understands that $13,000,000 is to be expended in widening the gage and in improvements.

FIRE AND WATER TEST OF VULCANITE FIREPROOF FLOOR, PHILADELPHIA, PA.

A fire and water test of the Bromley patent fireproof floor was made on Jan. 15, for the Vulcanite Paving Co., by Wilson Bros. & Co., Architects and Consulting Engineers, of Philadelphia, Pa. The test was in charge of Mr. Howard S. Richards, of Wilson Bros. & Co. The floor and test-house are illustrated in the accompanying drawings, and the conditions and results of the tests are given in the following abstract from Mr. Richard's report:

The furnace used was 11 ft. wide, 14 ft. 4 ins. long and 8 ft. 11½ ins. from the top of the grate bars to the underside of the floor beams. The section of floor tested formed the roof of the furnace, and was what is known as Type F, vulcanite floor. It was constructed between 10-in. I-beams spaced 5 ft. c. to c., and consisted of concrete arches laid on plaster centers, with wire lath and cement plaster fireproofing for the lower flanges of the beams, and a wire lath and plaster flat ceiling suspended from the lower flanges of the beams. The floor system was finished on top with the usual 3-in. × 4-in. wood sleepers, spaced 16 ins. c. to c. and running at right angles to the beams and filled in between with concrete. The above general description of the furnace and the floor will be understood by reference to the drawings.

The plaster centers upon which the concrete arches were laid consisted of a plaster of Paris composition 1⅛ ins. thick, and had a rise of 5½ ins. This 5½ ins., together with the 1½ ins. thickness, gave the concrete floor arches a rise of 7 ins. These concrete arches were 3 ins. thick at the crown and had bearings on the lower flanges of the I-beams equivalent to about 50% of the length of the beams. The concrete was composed of one part Vulcanite Portland cement, two parts sharp Jersey gravel and five parts ordinary boiler cinders, twice mixed dry and the wet cinders and additional water added in the final mixing. The concrete filling between the sleepers over the beams was composed of one part Vulcanite Portland cement, two parts Jersey gravel and eight parts ordinary boiler cinders, properly mixed. The protection for the lower flanges of the beams was composed of ordinary No. 20 wire-lathing cloth, turned over the lower flanges and plastered with a mortar about 1¼ ins. thick, composed of one part Vulcanite Portland cement and two parts fine Jersey gravel.

The flat suspended ceiling was composed of 9-in. × 12-in. mesh Nos. 11 and 12 gages, electric welded wire cloth, wired fast to ¾-in. channels running at right angles to the beams, and spaced about 13 ins. apart. No. 20 wire-lathing cloth was wired fast to the underside of the electric-welded cloth and the whole was plastered with two coats of "Victor" plaster about ¾-in. thick. The ceiling channels were secured to the lower flanges of the I-beams in the usual manner by strap-iron clamps.

The testing furnace was built in November, 1900, the centers and concrete-floor arches were put in place on November 28, 1900, sleepers and concrete between them put in place November 30, 1900, and the "Victor" plaster was put in place December 28 and 29, 1900. It was intended that the tests should be made in the spring of 1901, but various causes, not directly connected with the floor, led to the postponement of the test until Jan. 15, 1902.

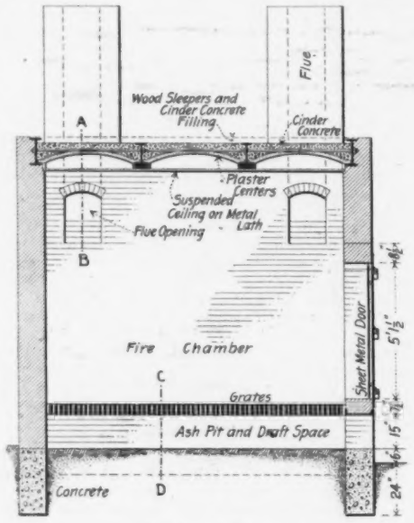


Fig. 1. Section and Plan of Test-House and Vulcanite Fireproof Floor, Arranged for Fire and Water Test.

Wilson Bros. & Co., Philadelphia, Pa., Testing Engineers.

In making ready for the test on the above date, rather unusual precaution was taken to secure an immediate high temperature, and to maintain this temperature practically uniform throughout the test. This was accomplished by connecting the draft space under the grate bars by a 16-in. pipe, to a steam-driven pressure fan which would deliver the proper amount of air necessary for the fiercest combustion. While it was understood that this blast system would produce a more destructive effect upon the floor construction than ordinary natural draft, yet it was considered expedient, on account of the previous behavior of the floor under ordinary fire conditions, to give the construction this extra test in order to prove its absolute fire-resisting qualities. The fuel used in making the test consisted of oak wood split into rather small pieces about 2½ ft. long and for the most part saturated with oil and grease, and was kept piled on the grate about 3 ft. high. Fire was started in the test furnace at 10.42 a. m., Jan. 15, and was kept going continuously until 2.03 p. m., when the water was turned on.

The inside temperature, as taken by the "Brown" water-current pyrometer, handled by a pyrometer expert, recorded about 1,500° F. at 11.35 a. m., and increased to 2,000° F. at 12 o'clock, and from that time on ranged from 2,000° to 2,135° F. until the water was turned on. As a matter of record, the expert in charge of the pyrometer stated that the standard water-current pyrometer registered about 140° less at a 2,000° reading than the air-current pyrometer often used in similar tests, and also that the actual temperature at the center of the roof of the furnace was at least 200° higher than that along the wall where the pyrometer was located; so that there must have been at times in the center of the furnace a temperature close on to 2,500° F. as measured by the usual air-current pyrometer.

In about one-half hour after the fire was started the metal ceiling had badly warped and the plaster had badly cracked. At about 12.15 the flames and gases had worked their way through the ceiling and at 12.45 it was practically destroyed; the plaster centers, however, lasted until about 1.30. The flames after working through the ceiling and plaster centers beat directly against the concrete arches and beam protections, and at the termination of the fire test at 2.03, these arches and beam protections were still in a sound and perfect condition, not even a crack being observable in either. As the concrete arches are assumed to form the entire structural part of the floor and also in the main the fireproof part of the floor, their behavior under every condition of test was satisfactory to the largest degree.

As illustrating the intense heat, even close to the side walls of the furnace, it may be mentioned that at 12 o'clock a glass "marble" was instantly melted upon introduction of an iron bar through one of the holes, and also at two instances thereafter pieces of copper were almost immediately melted upon being exposed to the heat. It may also be stated that the furnace walls and chimneys became badly cracked and eaten out, and in fact the only things that did not seem to be injured or disturbed were the steel beams, the concrete arches and beam protections.

At 2.03 p. m. the furnace door was opened and a stream of water from a 1¼-in. fire nozzle, at 65 lbs. per sq. in. pressure, was played upon the ceiling and side walls (principally upon the ceiling) for 10 mins., the water being turned off at 2.13. The only effect of the pounding action of this stream was to wash off some of the mortar composing the flange protection of the beams, and to pit the underside of the concrete arches to a very slight extent. None of the wire lath was burned or washed from the lower flanges and a good part of the cement-plaster protection still remained, and there were no cracks or holes or defects of any kind in the concrete arches.

The day previous to the test all three arches were loaded with slag bricks to the extent of 200 lbs. per sq. ft. of area of floor, and this load remained on during the fire and water test, immediately after which the center arch (which had been exposed to the fiercest flame) was loaded to the extent of 600 lbs. per sq. ft. None of this loading had any injurious effect upon the floor system, and the final loading was only discontinued when the furnace walls showed signs of collapse.

The duration of the test and the general conditions governing it were all arranged in accordance with instructions from Chief Hill, of the Bureau of Building Inspection of Philadelphia, Pa., and Chief Engineer Clark of the same bureau, both of whom were present during the entire time of the test.

FURTHER REPORTS ON THE JEROME PARK RESERVOIR.

The Jerome Park Reservoir controversy has been continued by letters to the Croton Aqueduct Commissioners from Mr. Elnathan Sweet, M. Am. Soc. C. E., of Albany, N. Y., and Mr. J. J. R. Croes, Past-Prest. Am. Soc. C. E., of New York city, and by responses to each by Mr. Wm. R. Hill, M. Am. Soc. C. E., Chief Engineer of the commission.

Before giving these letters and reports it may be stated that the main point at issue is whether or not a masonry core wall or cut-off wall should be carried to rock around the whole of the reservoir, which is partly in excavation and partly in embankment. The reservoir was designed while Mr. A. Fteley, Past-Prest. Am. Soc. C. E., was Chief Engineer of the Aqueduct Commission. The changes urged by Mr. Hill were disapproved in a report dated Nov. 18, 1901, made by a Board of Engineers, including Messrs. Croes and Sweet, named above, and Edwin F. Smith, M. Am. Soc. C. E., of Philadelphia (see Eng. News, Nov. 28,

1901). On Dec. 4, 1901, Mr. Hill made a report in which he stated that he did not coincide with the report of the engineers, and on Dec. 21, 1901, Mr. Smith, of the Board of Engineers, made a separate report, in which (while he stated he still held to the conclusions of the board), he set forth at length reasons why changes in design should be made, and approved the masonry cut-off walls already built by Mr. Hill, but not referred to the board for consideration (see Eng. News, Jan. 16, 1902). It now appears that copies of the reports by Messrs. Hill and Smith, respectively, were sent by Mr. Hill to Messrs. Croes and Sweet, as a matter of courtesy. Although these two members of the Board of Engineers sent independent letters to the Aqueduct Commission, yet so far as the engineering problems are concerned, the report by Mr. Smith, on the one hand, and the letters from Messrs. Croes and Sweet, on the other, may be considered as minority and majority reports, respectively, and as sequels to the original report.

The letters from Messrs. Sweet and Croes, and Mr. Hill's reply to each, are given in full below, with the exception of certain portions of the introduction to each, which refer to the various earlier reports, only. All the communications are addressed to the Aqueduct Commissioners.

LETTER BY MR. ELNATHAN SWEET.

. . . . . These reports are presumably sent to me for the purpose of obtaining an expression of my views upon them.

Mr. Hill's criticisms by the use of fragmentary quotations from the part of our joint report relating to Jerome Park Reservoir appear to me clearly misleading. Take, for example, the two quotations therefrom, which he cites on p. 4 of his report to you relating to the depression in the rock and in the natural surface at the south end of the Jerome Park Reservoir. Had he reproduced the exhibit of our report which faces the page from which these quotations are taken, and had he quoted the whole of the paragraph contained on pp. 28 and 29 of the report of which his second quotation is a part, he would have furnished an answer to all his criticisms upon our discussion of the questions relating to this part of the work. For this exhibit in connection with this paragraph of our report proves conclusively:

(1) That the fine sands are "confined" by overlaying coarser materials.

(2) That this depression at the south end of the reservoir is so much contracted between borings Nos. 2 and 3 as to create a summit between them with the ground water sloping gently northward towards the reservoir, and southward towards the Harlem River, and that the ground water continued to slope from this summit in these opposite directions after protracted pumping from pit No. 2, as well as when the water stood at its normal elevation within the reservoir site.

(3) They also demonstrate by the position and slopes of the ground water and by the slight effect of continued pumping at pit No. 2 that there is no outlet through this depression southward except by imperceptibly slow percolation.

(4) They show farther these topographic features: That the floor of the reservoir is here 6 ft. lower than the natural surface of the ground, and that this surface is practically level, a condition which the topographic maps of your department show to extend 2,000 ft. southward, in which distance the surface slope of this depression is but a few inches per 100 ft.

Mr. Hill suggests that the borings he had made for us to determine the character of the materials underlying the core walls are not conclusive as to the existence of quicksand.

The character of the wash water from these borings was carefully noted, which showed but small percentages of clay or loam where it was not entirely clear, and precludes the quality of instability or lateral movement under pressure in the stratifications tested, which is characteristic of true quicksand.

Conclusive proof that such lateral movement need not be apprehended under the finished embankment is furnished, as stated in our report, by the fact that though the materials under these core walls have been continually fully saturated since their completion the walls have not materially settled, though producing greater unbalanced pressure than will exist under the embankments when the latter are finished.

The erroneous diagnosis of those fine materials as quicksand doubtless arises from their behavior where pit and trench excavations are made in them while saturated, when it is a matter of common knowledge that the water entering the pit or trench below the sheeting under a head raises the sand, surrounds the particles with water and makes the mass exceedingly unstable or quick, and if the head and consequent velocity is considerable this phenomenon occurs with coarse sands. If the material be not a true quicksand the particles settle and become stable, even under water, after motion ceases which occurred with all the materials disclosed by our tests.

I beg to call your attention to Mr. Hill's criticism of our statement relative to the most northerly depression under the core wall that "the topographical maps and records of the borings in this vicinity furnished by your engineering department indicate that the rock rises rapidly outside this section of the embankment."

He calls attention to the fact that these borings show a test hole 210 ft. east of the core wall which disclosed no rock at Elevation 106, but admits the fact that they show rock at Elevation 126 at a point 75 ft. nearer the wall, and that both these facts are clearly stated on the diagram illustrating our report. These tests simply show that the ridge of rock disclosed at Elevation 126 slopes rapidly both west towards the reservoir, and east towards the site of the boring which at Elevation 106 did not reach rock. These indications are confirmed by the strong slope of the ground water towards the reservoir at this point disclosed by the borings outside and inside the core wall, as shown on the exhibit facing p. 31 of our report, a fact which excludes the existence of an outlet for the water eastwards from the reservoir at this point.

The slight effect of continued pumping in pit No. 1, 10 ft. square, located about 50 ft. inside the core wall, upon the ground water outside the core wall demonstrates the slight permeability of these materials to the passage of water.

Let us consider the effect of the possible seepage of water under these walls when the reservoir has been completed under the plans modified as we have recommended and in strict accordance with the specifications.

Any water passing thence from the bottom of the reservoir must pass through the concrete lining, through the

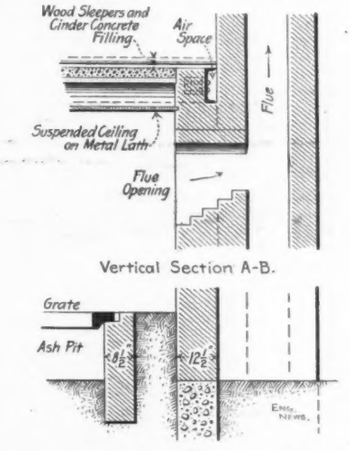


Fig. 2. Details of Floor Beam and Grate Connections, Vulcanite Fireproof Floor.

material under the concrete floor, which, by the terms of the specification, has been first drained and afterwards watered and heavily rolled; and thence through not less than 80 ft. of the fine materials we have described, under a wall not less than 10 ft. below the bottom of the reservoir; and if it be assumed to pass through the slope, its course is still longer in proportion to the head of water, and in either case must pass under the exterior embankment, and raise the line of ground-water saturation, now 12 to 18 ft. above the bottom of the core walls, in order to change the present conditions there. If it be admitted that any water or percolation from the reservoir may overcome all these opposing resistances it will simply raise the ground-water level above the sewer level to which the ground water now approximates, and would readily be drained through the sewers. The sinking of building foundations on Kingsbridge Road or Jerome Ave. could not be effected because the ground-water level would not be materially changed from that which now obtains there and because any method of sinking such foundations that would preserve the integrity of the street or avenue could not endanger the reservoir laying beyond it.

Mr. Hill and Mr. Smith cite the Queens Lane Reservoir at Philadelphia as comparable with this at Jerome Park, and as furnishing a warning against building this part of it as recommended in our report. The floor of the Queens Lane Reservoir was partly in excavation and partly in embankment, while this has its floor entirely in excavation. The inner slope of the former was 1.64 horizontal to 1 vertical, while the latter is to have a slope of 2.5 horizontal to 1 vertical. The former had exterior slopes about 1 to 1, while these slopes for the latter are to be 2 to 1. The core wall of the former was of mica clay, not extending below the reservoir floor, while in the latter the core wall is of masonry, extending at least 10 ft. below the reservoir floor.

The inner slopes of the former were lined with slabs of concrete, and the bottom with a layer of concrete only 4 ins. thick, where it joined the concrete slabs lining the slope; while the latter is to be provided with bottom-concrete lining at least four times as thick where the floor and slope intersect, and this intersection is to be monolithic, instead of separate construction, as at Queens Lane. The experts who investigated the defects in the Queens Lane reservoir reported the principal, if not the sole, cause of leakage to be the settling of the concrete slabs away from the 4-in. bottom lining of concrete, which our recommendation would securely guard against at Jerome Park, and the other superior features of the Jerome Park plans make the comparison between these reservoirs singularly inappropriate.

Mr. Hill criticises our recommendation that the inner earthen slopes of the reservoir be made 2½ to 1 instead of 2 to 1, as planned. It must be borne in mind that more than half the inner slope of the portion of the reservoir considered by us is in excavation, the material being fine sand and saturated with ground water, indicating clearly to our minds the desirability of a flatter slope than 2 to 1.

The change recommended not only increases the stability of the work, but it lessens its cost, as it but slightly increases the volume of embankment, greatly diminishes the volume of excavation, and diminishes the area of lining. Though the lining of the slope, which is increased in area, is more costly than the lining of the bottom, the area of which would be diminished by the change, the total cost would doubtless be reduced by the proposed flattening of the slope. The slight reduction in storage capacity which this change would effect is clearly negligible.

Mr. Smith's report to you, dated Dec. 21, 1901, in which he reiterates his agreement with all the conclusions of our joint report, the final conclusion expressed in the summary of the report being to the effect that if this part of the reservoir be constructed according to the contract specifications and the plans modified in accordance with our recommendation no large expenditure would be warrantable or advisable to stop the slight amount of seepage of water that might possibly be anticipated, seems to be animated by the fear that the work will not be executed in conformity with the contract, and therefore suggests expensive modifications of the plans which would relieve the contractor from onerous contract obligations. I do not believe public money can properly be expended to relax contract obligations where, as in this case, ample power is conferred on the engineer to exact and secure their specific performance.

(Signed) E. Sweet.

Albany, N. Y., January, 1902.

MR. HILL'S REPORT ON MR. SWEET'S LETTER.

. . . . . .

Mr. Sweet charges that my reprt is misleading, in relation to the depression in the rock at the south end of the reservoir, because I had failed to quote in full a certain paragraph. The portion of the paragraph omitted related to the surface of the ground water. He states that the depression is contracted, inasmuch as there is a summit in the slope of the ground water. A contraction might create a flatter slope above and a steeper slope below it, but I cannot conceive how it could create a summit in the surface of the water. I should be inclined to believe that there was water coming in from the side of the depression, from a spring or elsewhere. However, I have yet to learn of any cross-sections of the surface of the subterranean rock having ever been obtained or computed upon such a basis.

The diagram to which he calls your attention is a longitudinal section of the depression of the valley, and in nowise does it show a cross-section of the depression. A glance at the diagram should be sufficient to convince anyone that the natural surface of the rock will not, in any manner, assist in preventing leakage of water from under the wall and away from the reservoir.

Mr. Sweet states: "Our report proves conclusively that the fine sands are 'confined' by overlaying coarser materials." In answer to this I would say that either fine or quicksands, particularly where they are in contact with water, should be confined from spreading sideways, in order to form a stable foundation, and that any overlaying coarser material, under such a condition, has but little effect upon the stability of the sand beneath.

Relating to the topographical features, the communication states:

> That the floor of the reservoir is here 6 ft. lower than the natural surface of the ground and that this surface is practically level, a condition which the topographical maps of your department show to extend 2,000 ft. southward, in which distance the surface slope of this depression is but a few inches per 100 ft.

The diagram above referred to shows the upper 6 ft. of natural soil above the bottom of the reservoir to be light material (sand and loam); and yet the report of the Board of Engineers states that "the character of the topography adjoining the reservoir boundary convinces us that no serious leaks need be apprehended under this section of core wall founded on earth." Now, when we consider that the reservoir is to be flooded to a depth of 23½ ft., or to an elevation 17½ ft. higher than the natural surface of the ground, I cannot conceive how the topographical features of such loose material can convince anyone that no serious leak need be apprehended.

Mr. Sweet states:

If it be admitted that any water of percolation from the reservoir may overcome all these opposing resistances it will simply raise the ground-water level above the sewer level to which the ground water now approximates and would readily be drained through the sewers.

If the ground-water level was raised in the street it would also be raised in the adjoining property, hence there would be claims for damages against the city; and, further, there is no assurance that the amount of leakage would not be in excess of the carrying capacity of the sewers. When we consider that the city has expended many millions of dollars in constructing collecting reservoirs and aqueducts, it seems to me that it would be parsimonious not to construct the Jerome Park Reservoir in such a manner as will best prevent a continuous wastage of water in the sewers and allay all fear of its breaking away.

Mr. Sweet states that in my criticism of the report of the Board of Engineers relative to the most northerly depression I call attention to the fact that these borings disclose no rock at Elevation 106 at a point 210 ft. back of the wall, but that I admit that rock was found to be 20 ft. higher than Elevation 106 at a point 75 ft. nearer the wall. I must take exception to ever having made such an admission; the high point that Mr. Sweet refers to is not back of that part of the wall built upon quicksand, it is on the side of the depression and does not extend across it; hence the sand is not confined in a basin of rock, as shown on the diagram accompanying the report of the Board of Engineers.

Mr. Sweet states that the bottom of Queens Lane Reservoir was lined with concrete 4 ins. thick, but fails to mention that it was laid upon a prepared bed of clay 2 ft. thick, and that it broke away under a depth of only 10 ft. of water. The plans of Jerome Park Reservoir, which will be 26½ ft. deep, provide that the bottom shall be lined with concrete without any clay bed.

I have nothing further to add to the opinion expressed in my former report relative to the character of the material under the walls, the recommendation of the Board of Engineers to flatten the inner slope of the embankment, or the result of the pumping tests, showing that water is now flowing under the walls.

(Signed) W. R. Hill, Chief Engineer.
Jan. 27, 1902.

LETTER BY MR. J. J. R. CROES.

In transmitting to me, on Dec. 24, 1901, copies of (the reports in question—Ed.) . . . . . gave me no intimation that any further communication from me was desired or invited by you and consequently I merely acknowledged the receipts of the documents he forwarded.

I have, however, just been informed by Mr. Elnathan Sweet, C. E., that he has sent to you, in reply to a similar communication made to him by Mr. Hill, a statement commenting on certain criticisms of portions of our joint report of Nov. 18, which are made by Mr. Hill and Mr. Smith in their later reports to you.

It appears under these circumstances, that it is incumbent on me to submit to you my own views on the matters treated in these reports, that I may not be left in the position of appearing even to assent by silence to representations which display a serious misapprehension of facts and principles.

While expressing his entire concurrence with the findings of the Board of Engineers, of which he was a member, as to the unquestionable stability of the embankment built with a core wall in its center, on the south and east sides of the reservoir, Mr. Smith fears that at some future time the constructors of buildings with deep foundations on the opposite side of Jerome Ave. and Kingsbridge Road may attribute the presence of water in their excavations to leaks from the reservoir.

As a matter of fact, there is no point on the line of the further side of these avenues where the rock bottom is lower than the present ground-water level, except for about 400 ft. along the Kingsbridge Road at the south end of the reservoir. All along the east side of Jerome Ave. the rock is about 10 ft. higher than the ground-water level, except at 198th St., where there is a narrow depression in the ridge, rock being found at the elevation of the water table at 180 ft. from the core wall and falling off rapidly towards the east. This is the point alluded to by Mr. Hill, when he says that no rock was found at the Elevation 106, which is 5 ft. lower than the water level. He omits to state that this point was 210 ft. from the wall, and that 30 ft. nearer the wall two borings 45 ft. apart showed rock at Elevations 116 and 117. The possibility of water leaking from the reservoir being encountered on the opposite avenue frontage is limited to a strip of the south side of Kingsbridge Road, where there is a depression in the rock barrier, triangular in form, about 400 ft. wide at the top and 40 ft. deep in the center. There will always be water there, whether the reservoir is made water tight or not. The object sought in building the reservoir bank across the valley 150 ft. north of this depression is to prevent the passage of any more water through this gap than has been flowing there from time immemorial.

The existing conditions are clearly not appreciated by either Mr. Smith or Mr. Hill. A study of the topography, the geology and the general conditions existing in this locality, shows that there is here a long and narrow depression, about an eighth of a mile wide, between two ridges of gneiss rock which has been subjected to glacial action at some remote period. The bottom of this valley is somewhat irregular, but along its center line it is at a pretty uniform elevation of 75 ft. above tide level.

For a depth of about 36 to 40 ft. it is overlaid with fine sand and gravel, the product of glacial action, with a very small proportion of any clayey matter. Over this there are deposits of ordinary glacial drift, compact, containing many boulders and not easily permeable by water. This bed of sand, overlying beds of disintegrated and rotten gneiss rock, full of seams and crevices, is saturated by water which must be supplied from some far distant source of greater elevation, for it rises through the fine porous sand to an elevation of about 112 ft. above tide level and stands there. The supply is very limited in quantity, for its surface level is very uniform, having a slight slope to the north and to the south from the summit at or near the Kingsbridge Road, the excess of supply passing off at a slow velocity, by percolation, where it encounters a pervious material, or over the surface, where a depression furnishes it an outlet. To the southward it comes to the surface about a thousand feet away and to the northward it appears on the surface at the swampy spots designated on Mr. Smith's latest map. From time immemorial these swampy spots have been drained off to the southward by ditches crossing the Kingsbridge Road and through vacant lots. The ordinary flow of water in these ditches has always been very small.

Now it is proposed to create in this valley a reservoir 25 ft. deep, with its bottom at an elevation about 4 ft. lower than the level of the ground water. Its surface will in general be a little above the level of the ground surrounding it, but in a few instances will be from 12 to 15 ft. above it. With the material obtainable in the vicinity, it is an easy task to construct water-tight earth embankments around the reservoir, above the surface of the ground. The difficulty lies in making the bottom water tight, placed as it is, on a bed of saturated sand with a water bearing, saturated rotten rock bottom.

The plan adopted by the Aqueduct Commission, and now in course of construction under the contract entered into in 1895, is to make a water-tight basin or ditch of concrete, the bottom flat and the side sloping, set on the sand bottom, which is carefully prepared for its reception, and on the surrounding carefully built earth embankment. The clauses of this contract which relate to the mode of construction of this basin, and which have been collated by Mr. Smith in his last report to you, for convenient reference, show clearly that the principal feature of the plan is the securing of a water-tight lining over the whole interior surface.

The plan now proposed by your Chief Engineer, Mr. Hill, is to surround the valley with a heavy wall of masonry, built up from the rock bottom of the valley and backed above the present surface of the ground with a bank of earth dumped in. This has been done at some points on the north and west sides of the reservoir.

This mode of construction is not applicable to the south end of the reservoir now under consideration: (1) Because the leakage cannot be prevented by building a masonry wall on the seamy and rotten rock composing the bottom of the valley, which would permit the passage of the confined water through the seams and crevices of the rock under the wall, where water has always had a passage, and (2) on account of the enormous expense attending the construction of such a wall without any corresponding advantages.

Around the south end of the reservoir there is now in the bank a masonry wall, which is built up from the bedrock for 1,050 ft. of its length, and for 1,200 ft. in all is founded on sand, 10 ft. below the bottom of the reservoir. I do not understand the object of this core wall to be to prevent all leakage from the reservoir. As is stated in our report on the New Croton Dam, core walls in embankments are generally not entirely water proof. They are intended as a safeguard against muskrats boring through the bank and against the "free passage of water." These objects are fully accomplished by a wall such as here exists, carried down 10 ft. below the bottom of the reservoir and 20 ft. or more below the surface of the ground outside of the embankment.

Security against leakage of water out of a reservoir located as this one is, must be afforded by the lining of the bottom and banks. Any water which may penetrate this lining and pass into the rock-water basin below it, cannot be prevented from filtering out into the surrounding ground by any system of walls or other barriers founded on the seamy, water-bearing rotten rock which constitutes the bottom of the basin.

The plans and specifications for this work fully provide for making the lining water tight, as is clearly shown by the convenient collocation of the several clauses relating to this subject, made by Mr. Smith. The only criticism he finds to make is that the contract does not provide for paying the contractor an extra price for preparing the bottom and bank for receiving the lining. His comment that this is not in accord with the best engineering practice, is entirely irrelevant to the questions now at issue, and is, moreover, incorrect. Conditions vary as to the best form of contract in different circumstances, and it is rather late now to say that a provision inserted in the contract of 1895, with the approval of such men as General Duane, George Walton Green and John J. Tucker, on the advice of Mr. Alphonse Fteley, and discussed, understood and accepted by the 18 firms of contractors which bid upon the contract, was injudicious or bad practice. At all events it is a part of the contract and has all the force of a legislative enactment. To enforce compliance with the contract requirements is the duty of the engineer, and Mr. Smith's report to you merely emphasizes what has been recognized from the beginning of the work, that the material needed for the purpose is to be found on the ground, but not in superabundance, and that intelligence and care must be exercised in its selection and preparation.

The proposition to place at the junction of the bottom and sides a footing wall, was carefully considered by the Board of Engineers, and was rejected as needless. In the form now presented to you by Mr. Smith, it is peculiarly objectionable, as leaving the dimensions and depth of such a wall entirely to the discretion of the engineer in charge of the work, who has already committed himself to the opinion that such a wall must be extended down to the rock bottom, in direct opposition to the judgment of the Board of Engineers, unanimously agreed upon.

In this matter, Mr. Hill's opinion seems to be based to a great degree on his misconception of the nature of the material underlying the reservoir, which he terms "quicksand."

This material is a very fine-grained sharp sand, containing little or no clay, and saturated with the water which issues from the underlying rock.

Such material as this will boil up and be "quick" on the surface when exposed to a stream of water entering it from below, as in the case of a pit or trench sunk in it with the sides protected by sheet-piling. It will not flow for any distance when its surface is allowed to take its natural slope. The water will drain out of it and it will maintain its position with an outer slope of generally not more than 1½ to 1. It is not compressible, and when subjected to a heavy load will not displace the adjacent material either laterally or vertically. It has sustained for four years the weight of the core walls built upon it 35 ft. high, without any appreciable settlement. It is, moreover, confined by the rock below, the solid earth which overlies it, and the hundreds of feet of similiar material extending up and down the valley.

It was the unanimous judgment of the Board of Engineers, based upon a careful examination of the material itself, and the water which was used in bringing it to the surface, that it is not a dangerous material on which to found a wall or an embankment, and that its stability would not be effected by an excavation in or beyond the adjacent avenues.

A dangerous quicksand under a foundation is one in which the particles of sand are rounded and are mingled with particles of clay in such proportion that the mass is plastic, and will be displaced laterally by pressure and will flow in mass when saturated. Such material is not found under the Jerome Park Reservoir at the south end.

I see no reason to alter or modify in any way the conclusions expressed in our report of Nov. 18, that this reservoir will be stable, and practically if not absolutely water tight, if constructed as therein recommended, provided that the construction is supervised by an engineer who will be possessed of sufficient intelligence and firmness to see that the contract requirements are strictly carried out and the specifications complied with, whether such compliance entails on the contractor an expense greater or less than the compensation to which he is entitled under his contract.

(Signed) J. James R. Croes, C. E.
Jan. 23, 1902.

MR. HILL'S REPORT ON MR. CROES' LETTER.

. . . . . .

The communication states that:

Security against leakage of water out of a reservoir located as this one is, must be afforded by the lining of the bottom and banks. Any water which may penetrate this lining and pass into the rock-water basin below it, cannot be prevented from filtering out into the surrounding ground by any system of walls or other barriers founded on the seamy, water-bearing rotten rock which constitutes the bottom of the basin.

In the above it is stated that any water which may penetrate the lining cannot be prevented from reaching the surrounding ground by a wall founded upon seamy, rotten rock; in this opinion Mr. Croes agrees with what I have always maintained: that the wall should be built upon a solid-rock foundation. If, in the progress of the work, the upper surface of the rock is found to be seamy, or rotten, it should be excavated to a firm foundation of "solid gneiss rock," the existence of which is noted upon a diagram accompanying the report of the Board of Engineers.

The sentence, "Security against leakage of water out of a reservoir located as this one is," seems to imply that Mr. Croes is of the opinion that the outer wall and embankment of this particular reservoir cannot be made water tight and that the lining must be depended upon to prevent leakage; and yet he states that "The difficulty lies in making the bottom water tight, placed as it is on a bed of saturated sand with a water-bearing, saturated rock bottom." In this he admits what I have always

asserted—that there will be great difficulty in making the bottom water tight.

Relative to the other engineering questions raised by Mr. Croes, I would state that they have been reviewed in previous reports upon this subject.

(Signed) W. R. Hill, Chief Engineer.

Feb. 3, 1902.

PROPOSED CHANGES IN THE NEW YORK ASPHALT PAVING SPECIFICATIONS.

Among the checks and counter-checks included in the charter for Greater New York is one providing for two Commissioners of Accounts. The primary object of this department appears to have been, as one would naturally suppose, to supervise the city bookkeeping and to see that all the city funds are properly accounted for. To ensure the attainment of this desirable end the commissioners were given broad general powers of investigation; powers which are, in fact, so vague that they require only a liberal interpretation to permit the officials in question to enter upon almost any kind of an inquiry, so long as it pertains to the municipal affairs. Acting upon this assumption, the commissioners have built up a more or less extensive bureau for technical investigations, including an "Engineering Department—Physical and Chemical Laboratory." In 1899, the commissioners issued a pamphlet of 63 pages on "Asphalt Paving," designed to show that this class of work was being handled in the interests of favored contractors, and particularly that such had been the case during the years 1895-6-7, or under the administration of Mayor Strong. Later on, the commissioners issued a report on cements, in which it was urged that nothing but Portland cement should be used hereafter in certain classes of public works.

On Jan. 14, 1902, or two weeks after Mayor Low assumed office as Mayor of New York, the commissioners forwarded to the new Mayor a proposed new form of asphalt paving specifications, accompanied by a brief letter of transmittal, from which we make the following quotations:

Dear Sir: In accordance with your recent request we herewith transmit you proposed specifications for asphalt pavements in paving contracts, to be used in lieu of present specifications.

The proposed new specifications are the result of the experience and investigations of our Chief Engineer, Mr. Otto H. Klein.

The work of preparing these specifications necessarily has been somewhat hastily done, but the changes proposed are the result of much study and consideration upon the part of our Chief Engineer.

As the proposed specifications in nearly every detail involve technical knowledge of which we are not personally possessed, we submit them upon the responsibility of our Engineering Department; at the same time we beg leave to say to your honor that we are fully satisfied of Mr. Klein's special qualifications for the preparation of such specifications.

We have reason to believe that the adoption of the proposed specifications in lieu of the present ones will result in creating free and open competition for asphalt paving contracts in this city. The natural result will be a reduction in the cost of such paving without any deterioration in quality, and, in the aggregate, a great saving and great advantage to the city will follow.

We stand ready to instruct our Chief Engineer to confer with the heads of other departments, or the engineers representing them, regarding these proposed specifications. They will, of course, before being finally adopted, be submitted for approval as to legal form, to the counsel to the corporation.

We shall hold ourselves and our engineers at the command of your honor or of any head of department for the purpose of preparing a new form of paving contracts embracing these specifications. . . . (Signed),

Wm. Hepburn Russell,
Edw. Owen.

Then follows a report by Mr. Klein which, in the main, is confined to a comparison of the old and the proposed new specifications.

SAMPLES.—The first changes recommended by Mr. Klein relate to depositing samples of the material which each bidder proposes to use. Under New Paragraph 11 the proposed specifications extend the time from 4 to 14 days (Sundays and holidays excluded in each case). The first sample required under the old specifications (1*) was 5 oz. of crude asphalt. This is changed to 16 oz. of:

(a) Crude bituminous rock, either sandstone or limestone or both; (b) crude Trinidad pitch; (c) crude asphaltum; (d) crude natural extracted bitumen.

Next (2) we have in place of "5 oz. of refined asphalt," without mention of its particular use, "8 oz. of the refined Trinidad pitch or asphaltum to be used in the asphaltic cement." Then (3) for "2 lbs. of the liquid asphalt flux or petroleum residuum," the new specifications call for "16 oz. of the petroleum tar or fluid petroleum residuum to be used as a bituminous flux in the preparation of the asphaltic cement." For (4) 8 oz. of asphaltic cement 16 oz. is substituted. In place (5) of "5 oz. of sand," we have 8 oz. of the sand to be used in—

(a) With the Portland cement to form the concrete base.
(b) With the asphaltic cement to form the street-surface mixture.

In the next section (6), relating to pulverized carbonate of lime, granite, or quartz, the weight is changed from 5 to 8 oz., and "blue stone or trap rock, to be used in the street surface mixture," is added. In place (7) of "4 lbs. of the paving mixture for the wearing surface" and the "formula used in its composition," the new section calls for

5 lbs. of the paving mixture as it is to be laid upon the street, accompanied by a sworn statement that it is composed of natural asphaltum or extracted bitumen, or the asphaltic cement No. 4, and the pulverized rock No. 6, and the sand No. 3b, of which samples have been submitted, and nothing else.

In the next clause (8), relating to binder mixture, 6 lbs. is reduced to 5 lbs. The old section (9) relating to bituminous grout, or paving cement for filling joints in granite block is omitted because it is not used "except incidentally" along street railway track.

The old specifications (10) required a sample of 6 lbs. of hydraulic cement wherever asphalt was to be laid on concrete. The new specification changes this to 12 oz. of Portland cement, without stating the purpose for which the cement is to be used, and then adds the following new clauses, comprising Sec. 11 of Paragraph 11:

11. A sample of not less than 16 oz. each of broken limestone, bluestone, granite or trap-rock to be used:
(a) With the Portland cement mortar to form the concrete base.
(b) With the asphaltic cement to form the binder.

No coal tar, blast furnace tar, coke oven tar, nor any product obtained therefrom, shall be allowed in any of these mixtures above enumerated. Nor shall any solid or semi-solid residuum from the distillation of petroleum be allowed. Nor shall any liquid residuum from petroleum of any kind be used for any other purpose than as a bituminous flux.

All of these samples will be considered to be fair average samples, of their kind, of the materials to be used upon the work bid for. In case a bidder is allowed a contract, he shall deposit a duplicate set of the above-named samples with the Commissioner of Accounts, before any contract shall be signed.

All the foregoing changes relate to New Paragraph 11. In commenting on these changes Mr. Klein states that they are designed to specifically require samples of all material used in constructing any asphalt pavement. He says that the old sections in question

are, in many respects, vague and too open to construction. Our aim has been to remove those objections, and to state definitely not only the materials that will be allowed and which have been proved by use to make good streets, but also to exclude those materials which have been proved to be bad or have not been proved to be good.

To do this the entire paragraph has been rewritten and each kind of material that wil be allowed is named and its use clearly specified when any ambiguity is possible. The changes have been made in the line of clearness of statement rather than to change the intent of the original work.

ASPHALT NOT HERETOFORE USED.—The next change proposed would entirely omit the following clause in the old specifications:

Any bidder purposing to offer a material for asphalt paving not heretofore used on streets paved under the jurisdiction of the Department of Highways must, in addition to the above requirements, file an original certificate, with a certified copy of the specifications whose terms it fulfilled, four full days (excluding Sundays and holidays) before the time of making his bid, which certificate must show some other city or cities, and the specific street, avenue or highway therewith, where pavement of such material has been laid, its area, which must be at least 10,000 sq. yds., the date at which it was accepted, which must have been at least two years previous to the issuance of the certificate, and that the said pavement has worn well and satisfactory; to be signed and duly acknowledged by the chief municipal officer having charge of such work in the city or cities where such pavement has been laid and by the city engineer under whose direction it was laid. Also a statement of the location and capacity, in square yards per day, of the works or factory, where the paving material is to be prepared.

This clause, Mr. Klein states, "has been rendered unnecessary by the more definite statements introduced above" (given in our abstract), besides which "it contained provisions that have provoked much objection, and tend to discourage free competition."

MAINTENANCE PERIOD.—This is cut down from 10 to 5 years. On this point Mr. Klein states:

Experience has proved that a guarantee of five years is sufficient, considering the high rate of interest that the city has to pay indirectly for bonds for longer maintenance, provided that the contractor shall be required to put the street in good condition at the end of the five years. The work should be inspected before final acceptance and discharge from guarantee bond, and if not in good condition it shall be relaid. We would suggest that before the contractor is discharged from his guarantee bond the engineer of the Highway Department should inspect the street and report it in good condition and repair.

ASPHALT PAVEMENT.—Under (Par. 15) the old specifications defined the pavement proper as a 1-in. binder course, and a 2-in. wearing surface, the latter to be "equal to the standard pavement mixture hereinafter described." Provision was then made for thoroughly cleaning the foundation before laying the binder course. The latter provision appears to be omitted from the new clauses under this head, which begin by stating that the pavement shall consist of a 6-in. concrete base, composed of "American Portland cement of the best quality, clean sand and broken stone, as specified" in a paragraph not included in the report. Upon this base, the next clause says, "shall be laid a surface of either 'Asphalt' or 'Rock Asphalt.'" If of "Asphalt," there shall be a 1-in. binder course and 2 ins. of wearing surface. This change, Mr. Klein explains, is required in order to "describe the whole pavement."

BINDER COURSE.—Section 16, Paragraph 1.* required "suitable clean broken stone passing a 1¼-in. screen, not more than 5% of which shall pass a No. 10 screen." The new clause calls for "(a) crushed limestone, bluestone, trap or granite rock" of the same sizes as before, and adds that "no crushed, weathered rock or boulders, pebbles, nor soil nor dirt will be allowed in the binder." The method of preparing the binder mixture calls, in each specification, for heating the stone to not over 300° F., then thoroughly mixing by machinery with the asphaltic cement, but from this point on the two specifications differ. The old one allowed a temperature, in mixing, of 300 to 325° F., while the new one says that 325° F. shall not be exceeded. Both specifications say, in effect, that the asphaltic cement shall be composed as described further on, but the old specifications add that "no cement composed of mixtures of asphalt and coal tar will be used." The old section makes the proportion of asphaltic cement and stone such "as shall be acceptable to the Commissioner of Highways," while the new one requires such proportions "that the per cent. by weight soluble in carbon disulphide shall not be less than 3 nor more than 5%."

The old specifications provide that the binder must have "life and gloss without an excess of cement," while the new ones require a mixture "so complete that every piece of stone shall be covered with cement."

The old sections on delivering and laying the binder, bonding it and protecting it from traffic are retained.

WEARING SURFACE AND VARIOUS DEFINITIONS.

Thus far we have attempted to save the time and patience of our readers by pointing out the actual changes which Mr. Klein has proposed, and which the Commissioners of Accounts have recommended for adoption. As Mr. Klein appears to attach most importance to his proposed changes in the specifications for the wearing surface, and to his definitions of the ingredients entering into this surface, including also the asphaltic cement for the binder, we quote in full the original and the proposed specifications on these points, in parallel columns on the following page.

MR. KLEIN'S COMMENTS ON THE FOREGOING.

Mr. Klein states that "Refined Asphalt" is not defined in the report, or if so only in terms that are "ambiguous and open to construction," and that there is an apparent synonymous use of "Asphalt" and "Asphaltum." He states that "Asphaltum" is a term

used from time immemorial to designate the solid, nearly pure form of bitumen, as it occurs in nature,

while "Asphalt" means

the mixtures of limestone or sandstone with bitumen in all proportions as they occur in nature.

Mr. Klein comments on the old specifications for "Refined Asphalt" as follows, the notations in parentheses relating to corresponding paragraphs in the original:

Refined Asphalt.—This language does not define or describe anything, nor does it specify anything. It does

*Numerals in parenthesis (1) to (10) inclusive, relate to corresponding sections of old Paragraph 11.

*Mr. Klein here changes his numbering from Paragraphs and Sections to the reverse order.

not even state the source of the crude material. Of course the crude material *must* be natural, as no material may be obtained outside of nature. Under this form of words *anything* may be used that may be *obtained* from "the crude, natural material." What material? Coal, petroleum, maltha, asphaltum, asphalt. In what way? Any way. Nothing is excluded from these specifications but coal tar and its products, and a few unusual by-products of the arts like candle-tar. The "pitch of blast-furnace tar" and "coke-oven tar" are not excluded. "Coke pitch" and the "residuums of petroleum" are not excluded, nor is "Pittsburg flux" made from either eastern or California petroleum nor blyerite. They are all obtained from crude, natural material; provided, that they "shall be in all respects satisfactory to the Commissioner of Highways."

(No. 2.) Accomplish what? Refined asphaltum or refined Trinidad pitch is never uniform in the same barrel, except within limits. This requirement is impracticable. Again, no crude asphalt is required in the above formula. Nor is any kind of asphalt required as the crude material. No form of words could be more ambiguous or mean less.

This requirement is wholly arbitrary. It cannot apply to any asphalt, as the richest asphalts contain only about 12% of bitumen. It cannot apply to asphaltums, for they all contain more than 80% of bitumen. It must apply only to Trinidad pitch, which is a unique substance, neither an asphalt nor an asphaltum.

The number (percentage—Ed.) 55 as applied to "refined Trinidad pitch" is purely arbitrary and has no significance as a constant by which the fitness of material may be determined for the construction of a street.

It has been found by years of experience, that no practicable difference is to be observed in the use of well-washed and dried samples of gasoline as they are found on the market. Such specific directions as to the specific gravity and boiling point are therefore of no value.

The percentage soluble in Pennsylvania petroleum ether (68) is too high. If rigidly applied, that percentage would exclude nearly everything now on the market, except Trinidad pitch, that has been oiled in refining, and Ventura flux and Kentucky rock.

Very few street surfaces, even with their content of petroleum tar, yield such a large percentage as 68, and the larger proportion of "refined Trinidad pitches," including many lake pitches of unquestionable good quality, fall below 68%.

We lately have seen a table which included 65 analyses of 25 crude and refined asphaltums, asphalts and residuums, including Trinidad pitch. Of the 65 specimens, but 21 yielded 68% of total bitumen, soluble in petroleum ether. Of the 65 analyses, 51 gave more than 60% so soluble. Of 11 analyses of refined Trinidad pitch, 3 were above 70%, all of which were oiled in refining; 5 were above 68%, including the 3 last mentioned, and all were above 62%. They were all samples of good refined Trinidad pitch. The 21 samples mentioned above that were above 68% included 10 varieties of the 25 that were represented. Seyssel rock, Gilsonite, Bermudez and California asphaltums are excluded by this requirement and Ventura flux and other California residuums are admitted.

The requirement is wholly arbitrary and in the interest of the Trinidad Lake monopoly.

Continuing with No. 2, Mr. Klein quotes (italics) fragments of the old specifications and comments on them, as follows:

it shall soften at from 189° *to* 1 2° *F.;*

As all asphaltums and Trinidad pitch soften with any increase of temperature, this requirement is perfectly useless, unless the word "soften" is carefully defined and limited.

and flow at from 200° *to* 210° *F.;*

This requirement is, like the softening, purely arbitrary, and of no value unless the word *flow* is defined.

it shall volatilize from 2½ *to* 3% *of oil in* 10 *hours at a temperature of* 400° *F;*

This is an absolute declaration leaving a possible variation of only ½%; such a requirement is wholly without significance unless the method of conducting the experiment is described and followed to the minutest detail.

it shall have a specific gravity of approximately 1.38;

This requirement applies to nothing on the market but Trinidad pitch, and if rigidly enforced would exclude everything else.

and shall be free from all manner and form of adulteration.

This requirement means absolutely nothing, following the vague and meaningless requirements that precede it.

After the evaporation of the solvent, the pure bituminous matter soluble in carbon bisulphide shall be adhesive, malleable and ductile at temperatures ranging from 70° *F to its liquifying point.*

This is an absolutely meaningless requirement, and describes nothing. There is no bituminous material used in street pavement that is not soft enough at 70° to be adhesive. Malleable and ductile are terms applied to metals and have no meanihg as used here.

It shall soften at 168° *F. and flow at* 180° *F.*

This requirement is positively absurd, as it could not be applied to any one brand of material on the market with which we are acquainted, and yet the requirement is an absolute declaration.

NO. 3.—HEAVY PETROLEUM OIL.—In the first paragraph Mr. Klein says:

The substance herein described is reduced oil, prepared for use in lubricating the axles of railroad cars, and is not on the market for use in street paving. It contains usually a large percentage of paraffine.

The "petroleum tar" in use for street paving is a product of destructive distillation and should be as free as possible from parafine. It cannot be made without cracking.

He also declares that "both a flash and a fire test are useless."

NO. 4.—ASPHALTIC CEMENT.—The first paragraph is dismissed with the remark that "no composition is stated in any of the foregoing paragraphs." In the second paragraph Mr. Klein says:

These very elaborate directions for the preparation of asphaltic cement are after all vague and entirely inadequate.

The essential property of an asphaltic cement, namely, that the asphaltic material and the oil *shall be completely blended and dissolved in each other*, is not mentioned.

It does not make a particle of difference what the proportions may be, how long they are blown and at what temperature below 400° F., whether or not the mixture is lumpy or whether or not it is satisfactory to anybody, if the blending of the two components is not complete.

No test to ascertain this condition is mentioned, and, indeed, its fundamental importance does not appear to

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REASONS FOR THE CHANGES IN REFERENCE TO WEARING SURFACE.

The present specifications contain a number of technical terms that are nowhere defined, but are left open to construction. We have rewritten the matter and have preceded it by clear definitions of these terms in such manner as to make the statements clear and definite, leaving out the necessity or possibility of construction as far as it may be possible. As these definitions are new they do not correspond to anything in the present specifications.

Present Specifications.

STANDARD PAVEMENT MIXTURE.

Section 17, Par. 1. The standard pavement mixture for the wearing surface shall be composed of:

1. Asphaltic cement. { Refined asphalt. / Heavy petroleum oil or liquid asphalt.
2. Clean, sharp sand.
3. Finely powdered carbonate of lime, granite or quartz.

Refined Asphalt.—The asphalt for use in the manufacture of the asphaltic cement for the preparation of the standard pavement mixture shall be obtained from the crude, natural material, and shall be in all respects satisfactory to the Commissioners of Highways.

Par. 2. To accomplish this the crude asphalt must be refined until the product is uniform in composition, quality and specific gravity. The refined asphalt shall contain not less than 55% of bitumen soluble in carbon bisulphide, of which bitumen at least 68% shall be soluble in Pennsylvania petroleum naphtha of a specific gravity of 72° Beaume (boiling points —80° to 90° C.), it shall soften at from 189° to 192° F., and flow at from 200° to 210° F.; it shall volatilize from 2½ to 3% of oil in 10 hours at a temperature of 400° F.; it shall have a specific gravity of approximately 1.38, and shall be free from all manner and form of adulteration. After the evaporation of the solvent, the pure bituminous matter soluble in carbon bisuiphide shall be adhesive, malleable and ductile at temperatures ranging from 70° F. to its liquifying point. It shall soften at 168° F. and flow at 180° F.

REQUIREMENTS FOR HEAVY PETROLEUM OIL.

Par. 3. Heavy Petroleum Oil.—The oil used in the manufacture of the asphaltic cement, as hereinafter described, shall be a petroleum from which lighter oils have been removed by distillation without cracking, until it has a specific gravity of 18° to 22° Beaume and the following properties:

(a) Flash test not less than 300° F. (The flash test shall be taken in a New York State closed oil tester.) (b) Fire test, not less than 350° F. (c) No appreciable amount of light oils or matter volatile under 250° F. (d) Distillate at 400° F. for 30 hours, less than to 10%. (The distillate shall be made with about 50 grammes of oil in a small glass retort provided with a thermometer and packed in asbestos.) (e) It shall be free from foreign matter and coke.

Par. 4. Asphaltic Cement.—Asphaltic cement, manufactured from refined asphalt and heavy petroleum oil agreeing in composition and properties with those described in the foregoing paragraphs, shall be prepared in the following manner:

Preparation of Asphaltic Cement.—To the melted asphalt, at a temperature of not over 325° F., the oil, after having been heated to at least 250° F., is to be added in suitable proportions to produce an asphaltic cement satisfactory to the Commissioner of Highways. To accomplish this from 18 to 21 lbs. of oil per 100 lbs. of refined asphalt will be required. As soon as the oil has begun to be added, suitable agitation by means of an air blast or other acceptable appliance shall commence and be continued until a homogeneous cement is produced. The appliances for agitation shall be such as to accomplish this in ten hours, during which time the temperature shall be kept at from 250° to 350° F., and no higher. If the cement then appears homogeneous and free from lumps and inequalities, it may be used. Should it not prove satisfactory, such deficiencies as may exist shall be corrected by the addition of hot oil or melted asphalt in the necessary proportions.

Requirements for Asphaltic Cement.—Asphaltic cement shall fulfil the tests enumerated for heavy petroleum oil, and after being kept in storage must be thoroughly agitated when used, as must also all dipping kettles while in use. Samples of the asphaltic cement and of the heavy petroleum oil and refined asphalt shall be supplied to the engineer when required in suitable tin boxes and cans, and he shall have access to all branches of the work at any time.

Requirements for Softening Agent.—Should a liquid asphalt or other softening agent be used as a substitute for a portion or for all the heavy petroleum oil in making the asphaltic cement, such softening agent must be approved by the commissioner and shall fulfil the test enumerated for heavy petroleum oil; it must contain not less than 95% bitumen, and its acidity in terms of caustic potash must not exceed 2%. The softening agent shall be such that when added to the refined asphalt in proper proportion it will produce an asphaltic cement having essentially the same consistency and the same properties as that made of refined asphalt and heavy petroleum oil, as hereinbefore described, or properties that shall be considered and accepted by the Commissioner of Highways as equivalent or superior thereto.

Sand.—The sand to be used shall be hard grained, moderately sharp and clean, not containing more than 1% of clay or loam. On sifting, the whole of it shall pass a 10-mesh screen, 20% shall pass an 80-mesh screen, and at least 7% shall pass a 100-mesh screen.

Proposed Specifications.

WEARING SURFACE.

The "Wearing Surface" shall be made and laid according to the following specifications, the materials which shall be used therefor shall be:

1. Asphalt.
2. Bituminous flux.
3. Sand.
4. Pulverized rock.

These several words and terms shall be defined and construed throughout these specifications to mean as follows:

1. 136. The word "asphalt" shall be construed to mean refined Trinidad pitch, refined asphaltum, crude asphaltum, that does not need refining—natural extracted bitumen—and nothing else. The Trinidad pitch or asphaltum shal be refined until homogeneous, and when so refined shall, with the natural asphaltum or extracted bitumen, be free from water and light oils. They shall be carefully refined, and shall not, at any time, be heated to a temperature high enough to injure them.

2. 137. The words "bituminous flux" shall be construed to mean what in commerce is known as petroleum tar or heavy petroleum, or maltha prepared for use as a flux, by being freed from water and light oils. From whatever source it may be obtained, it shall possess the following characteristics:

138. It shall not flash below 300° F. when tested in a New York State closed tester; it shall not yield when heated an appreciable amount of distillate below 250° F. nor when heated for 30 hours at 400° F., shall the distillate exceed 10%. The distillation shall be made with about 50 grams of flux in a small glass retort, provided with a thermometer, and packed entirely in asbestos. The residuum remaining in the retort after distilling must flow at 75° F., and must not be coarsely crystalline on cooling. The more free it is from paraffine the better, it shall be free from an appreciable amount of coke.

3. 139. The word "sand" shall be construed to mean clean, hard-grained and sharp sand. On sifting at least 15% shall be caught on a 40-mesh per inch screen, 25% shall pass an 80-mesh to the inch screen, and 10% at least shall pass a 100-mesh to the inch screen. If the sand to be used does not contain the desired fined material, limestone, dust or other pulverized rock can be added to make up the deficiency. Sand containing clay or loam shall not be used.

4. 140. The words "pulverized rock" shall be construed to mean finely pulverized limestone, bluestone, granite or trap, the whole of which shall pass a 30-mesh to the inch screen, and at least 75% shall pass a 100-mesh to the inch screen.

5. 141. The words "asphaltic cement" shall be construed to mean "asphalt" which has been softened and tempered with "bituminuos flux" in such manner as to properly prepare it for use in the "asphalt paving mixture." When the "asphalt," whether previously refined or not, is not already of the proper consistency, it shall be tempered with "bituminous flux" at a temperature not to exceed 350° F. To accomplish this they shall be combined in proportions not to exceed 25 lbs. of "bituminous flux" to 100 lbs. of "asphalt." The "asphalt" shall be melted at a temperature not to exceed 350° F., and the "bituminous flux," after having been heated to at least 250° F., shall be added slowly and the mixture agitated by an air blast, or other suitable means, until a complete blending of the two ingredients is effected, resulting in a homogeneous cement. When "asphaltic cement" contains more than 10% of mineral matter it must be thoroughly agitated when used, as must all dipping kettles when in use.

6. 142. The words "asphalt paving mixture" shall be construed to mean a mixture of

12-15% asphaltic cement,
83-70% sand,
5-15% pulverized rock.

The proportions of these ingredients shall be determined by weight and shall depend upon their kind and quality and the traffic upon the street. The mixture shall conform to the following requirements, viz.: It shall be homogeneous and tenacious, free from brittleness at ordinary temperatures, and it shall not be too soft to sustain the traffic in hot weather nor so hard as to be brittle in cold weather; it shall not contain less than 9% nor more than 12% of total bitumen, including flux, that will dissolve in carbon bisulphides. It shall be compounded after the following manner. The sand, or the mixture of sand and stone dust and the "asphaltic cement," shall be heated separately to about 300° F. The "pulverized rock" while cold shall be mixed with the hot sand in the required proportions, and then mixed with the "asphaltic cement," at the required temperature and in the proper proportions in a suitable apparatus, so as to effect a thoroughly homogeneous mixture. Sand boxes and asphalt gages must be weighed in the presence of inspectors as often as may be desired. The paving mixture, of whatsoever materials or in whatsoever proportion it shall be compounded, shall be compounded according to the demands of the best state of the art and in a skilful and workmanlike manner. If the proportions of the mixture are found to be improper or the mixture is unskilfully prepared, it will be condemned, its use will not be permitted, and, if already placed upon the street, it shall be removed and replaced by materials in the proper proportions and of the required quality at the expense of the contractor.

7. 143. The asphalt paving mixture shall not contain any coal tar or blast-furnace tar or coke-oven tar nor any product prepared from them. Nor shall it contain any solid or semi-solid residuum of petroleum nor any liquid residuum of petroleum other than is contained in the bituminous flux, but it shall be compounded of asphaltic cement, sand and pulverized rock, as above described, and nothing else.

have been within the knowledge of the author of the specifications.

The first sentence under "Requirements for Softening Agent," is thus dealt with:

Precisely what this means as it stands, or how it may be interpreted, we are unable to say. We have never encountered in chemical literature a parallel passage! It is possible that the author of this requirement knows what it means, but we doubt it.

It is possible that "liquid asphalt" may be found with an acid reaction, but what relation that may have to "caustic potash" that can be expressed in percentage terms is, without further explanation, a mystery.

ROCK ASPHALTS.

Under this head (which is numbered Sec. 19) the specifications are broadened to include bituminous sandstone, as well as limestone, either separately or mixed with the limestone. The change is explained as follows:

There are practically no natural bituminous limestones available for use in New York city. All such have to come from Europe or the Indian Territory.

There are, however, natural bituminous sandstones in Kentucky, that when mixed with bituminous *limestone* are used for street pavements, and are excluded from competition by Section 19.

GENERAL REQUIREMENTS.

Section 20, the report states, is a condensed summary of Secs. 16 and 17. In the following paragraph all the matter *not* in parenthesis, without regard to the type used, is the original section; all the matter in italics, whether in parenthesis or not, is the proposed new specification; the portions in parenthesis indicate the changes made by Mr. Klein:

(20) General Requirement.—The asphalt for use under contract shall be one agreeing in composition and proportion with that described in the foregoing section, or one having composition and properties which are equivalent or superior thereto *as determined by the Commissioner of Highways: But whatever may be the (proportions or qualities)* character *of the asphalt (or rock asphalt) used or the manner of manipulation and laying the pavement obtained* must and *shall conform to the following general requirements:* The pavement when laid *shall not be so soft as to be unfit for travel on the hottest days of (in) summer, nor so hard as to disintegrate from the effects of* frost *(the severest winter cold). When laid it shall be equal in consistency, surface and durability to the* standard pavement made as hereinbefore described *(to the best pavement of its kind). It shall contain no water nor appreciable amount of light oils nor matter volatile at a temperature under (of)* 250° *F. It shall yield,* when extracted with bisulphide of carbon and after evaporation of the solvent not less than 9 nor more than 12% of pure bituminous *matter (soluble incarbon bisulphide). The extracted bituminous matter shall have a fire (flash) test of* 350° (300) *F.*, and shall not possess any marked acidity to caustic potash. *All of the mineral matter shall pass a 10-mesh per linear inch sieve (screen) and not less than 15% shall pass a 100-mesh per linear inch sieve (screen)*, while the remainder shall be graduated between these limits. *If rock asphalt be used the mineral matter shall be that which occurs in the natural product. In case of repairs, it will be required that such repairs* shall *match* in color the *original pavement (in kind quality and color)* and be made with a pavement mixture equal to the above described.

Mr. Klein's comments on the foregoing section, together with his final criticisms of the old specifications as a whole, are as follows:

This section (20) is a condensed summary of sections 16 and 17. While agreeing with them in the main, it is sufficiently different to lead to confusion if it is strictly interpreted, as it should be.

No composition is given in those sections for either refined asphalt or heavy petroleum oil. The properties enumerated are in the main exclusively those of Trinidad pitch, and they are so stated as to exclude the natural California asphaltum on the one hand and Kentucky rock on the other. The clause, "but whatever may be the character of the asphalt used," does not afford any relief to the requirements of the other clauses, which are mandatory.

ON THE OLD SPECIFICATIONS AS A WHOLE.

These specifications are a rather clumsily devised scheme to restrict the use of natural bituminous minerals to Trinidad pitch. While doing this *practically*, there is an apparent attitude of free competition that is without reality. There is also an apparent restriction to the use of natural bitumens that is only apparent. The several varieties of petroleum residues, and particularly those from California, are not excluded, either specifically, nor in general terms, whatever may have been intended. The properties of bituminous minerals that would be effective in securing good streets and excluding bad ones, are nowhere mentioned, while a number of properties common to all bituminous minerals are made mandatory in such vague terms as to be practically without value. On comparing these criticisms with the material submitted, we think it will be manifest that, while a large part remains unchanged, the specifications have been made broader, clearer, more specific, and less open to construction.

Perhaps it should be added that under the amended charter, which went into effect on Jan. 1, 1902, the streets are under the control of the several borough presidents, who are elected by popular vote, instead of, as formerly, under the direction of a single commissioner of highways, appointed by the Mayor.

No action has yet been taken, so far as we can learn, on the report of the commissioners of accounts. The full report was printed on Jan. 16, 1902, in the "City Record," which is the official organ of the city, and has its office in the city hall.

THE PROPOSED TAUNTON RIVER AND BOSTON HARBOR SHIP CANAL.

From the detailed report of Mr. Frank W. Hodgdon, M. Am. Soc. C. E., Engineer to the Board of Harbor and Land Commissioners, of Massachusetts, an abstract is made of the surveys and estimates for a proposed ship canal connecting Narragansett Bay and Boston Harbor, by way of the Taunton and Weymouth Fore Rivers.

A depth of 25 ft. was adopted as sufficient for the use of coastwise vessels; and with a width of 60 ft. in the locks any naval vessel—except a battleship—could pass through the canal. The width of the canal was fixed at 130 ft. on the bottom, with side-slopes of 1 on 2 in earth sections, and with vertical sides in rock.

In general, the line selected starts in Weymouth Fore River, near the bridge at Quincy Point; thence follows this valley to Weymouth Landing; thence up the valley of Smelt Brook and through the divide into the valley of the Monatiquot River; thence up this valley, across Dyer Hill and through the divide, near Avon Station, into the valley of Trout Brook; along this valley and that of Salisbury Plain River, through the City of Brockton, and through the divide to Tom River; thence along the valley of Tom River, and through the divide into the valley of the next stream south, a tributary of the Taunton River; thence down this valley and that of the Taunton to Weir village, in the City of Taunton; and then following this river to its mouth in Mount Hope Bay.

The total length of the line proposed is 31.79 miles, between the ends of the approach structures, or tidal locks. Of this length 22.33 miles is straight line; 9.46 miles are on curves of from 2,000 to 10,000 ft. radius; 2.22 miles on curves of less than 5,000 ft. radius. On all curves of less than 10,000 ft. radius the width of the canal was increased, according to a fixed formula.

The necessary water supply was an important question; and as a basis for calculation—founded upon the actual arrival of vessels at Boston from Southern ports—in 1900, 20 lockages per day were assumed. The locks south of the summit level vary from 16 to 21 ft. lift; and on the above basis it would require 30,000,000 cu. ft. of water per day to operate them. To provide for seepage, 3,000,000 cu. ft. per day were added to the above, making 33,000,000 cu. ft. There is no drainage area near the canal sufficiently large to supply this amount of water at the summit level elevation; and to bring water from the Blackstone River would require an aqueduct 30 miles long, largely in tunnel. For these and other reasons it is deemed advisable to pump the water required from the Weymouth Fore River to the summit level, using four sets of pumps operated by electricity.

The highest point on the canal line is about 160 ft. above mean sea level, and is just north of Brockton. The water surface in the summit level has been fixed at 130 ft. above mean tide. The estimates provide for five locks, each of 25 ft. lift, in addition to the two tidal entrance locks. These locks would be 60 ft. wide and 550 ft. long between hollow quoins; this length being divided into two chambers of 350 and 200 ft., by a set of middle gates. The depth on the sill would be 25 ft. The gates would be steel, of the standard miter form. Guard gates would also be placed at both ends of all three single locks, and at the foot and head of the combined lock at Weymouth Landing.

The proposed line crosses the various lines of the New York, New Haven & Hartford R. R. at eight places, in addition to existing drawbridges at three places; but at four of these places crossings can be avoided. In all, 46 highways now cross the canal line; and estimates have been made for 14 drawbridges, and for rearranging and diverting some of these highways. All railway bridges will be for two tracks—except at Campello, where four tracks are required. The highway bridges will be 50 ft. wide over all, with a 34-ft. roadway; and in most cases the clear width for passing vessels will be 100 ft., with 60 ft. as a minimum. Turning basins, 600 ft. square, are provided at Taunton, Brockton and Holbreck.

The detailed estimate of probable cost is as follows:

Excavation, including approaches between Quincy Point bridge and Slade's Ferry bridge	$20,103,962
Backfill	908,060
Culverts and by-passes	980,000
Retaining walls	1,494,660
Puddle walls	144,317
Wash walls	1,196,072
Spillway and waste weirs	815,000
Stop gates	300,000
Highway changes	343,100
Railroad changes	462,000
Highway bridges	1,623,000
Railroad bridges	1,580,000
Dams	170,000
Locks	12,233,000
Lock approaches	2,406,620
Power and lighting plant	220,000
Water-supply plant	2,532,499
Maintenance plant	200,000
Right of way and damages	2,580,910
Engineering and contingencies, 15%	7,515,438
Total	$57,618,358

CRITICISMS OF THE NEW YORK ASPHALT PAVEMENT SPECIFICATIONS.

By A. W. Dow.*

Having received a copy of the "City Record" of the City of New York, containing a discussion of the present specifications for asphalt paving, and also containing a proposed new one, both by the Engineer of the Commissioners of Accounts, and being requested to criticise the same, I herewith submit a few remarks, hoping they may aid in compiling more desirable specifications.

The question of asphalt specifications has always been a vexing one, and I have yet to see one that is entirely satisfactory. This is primarily due to the fact that no two asphalts are identically alike, and, necessarily, to produce results in pavements that are similar all have to be treated differently. In writing specifications it is generally considered necessary to fix limits as to temperature, duration of treatment, proportions, etc., in each step in the manufacture of a pavement, and it is easy to conceive how the extremes of such limits while being desirable for one asphalt may at the same time be most injurious to another. For this reason we should avoid any limitation as to the description of the crude or refined asphalt and avoid any limit as to the amount of flux necessary in softening the asphalt into the paving cement. In fact, I believe that were it not too radical a departure from existing paving specifications, the qualities of the asphalt paving cement alone should be specified, for by rights the contractor should produce his asphalt paving cement from whatever material and by whatever means he chooses, so long as it answers the purpose for which it is intended.

In specifications for hydraulic cements we do not request the manufacturer to hand in samples of all the materials that he uses in making his cement, along with the sworn statement of the proportions he used. What we do is to specify that his hydraulic cement shall give certain results when tested chemically and physically. This is what we should do with the asphalt specifications, specify that the asphalt cement should have certain chemical and physical properties, and our present knowledge of the subject is sufficient to make this possible.

In taking up the present and proposed new specifications, as given in the "City Record," the first paragraphs treat of the samples of the various materials that the bidder is required to deposit with the commissioner, along with various statements in reference to the samples. I can see no advantage in the proposed specifications over the old ones in these paragraphs, and there are several objectionable features.

In Sec. (1) and especially in Sec. (2) of Paragraph 11 of the new specifications Trinidad is differentiated from other asphalts. Why can it not be included under a general head of crude or refined asphalt? Such special mention with no apparent advantages savors of advertising a particular brand of asphalt.

In both the present and the proposed new specifications the formula for the composition of the asphalt cement, asphalt-paving mixture, and binder are requested. This I do not consider just to the contractors having no paving plant at the time of the bidding in the city or vicinity, but who would bring in a railroad paving-plant or erect one for the work. Such a contractor would be forced to ship considerable of the materials, such

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as sand and stone, which he proposed using in his contract, to his nearest plant, or be forced to make up small samples by hand, and samples made by hand or on a small scale are never comparable with those made by machinery on a large scale.

Paragraph 11, Sec. 11 (first two lines of our reprint.—Ed.), in the proposed new specifications is too specific without apparent reason, and would be better if it read, "a sample of not less than 16 oz. each of any hard stone crushed or broken, as specified to be used," etc. There is other desirable stone besides limestone, bluestone, granite and traprock that is available for such purposes.

I would propose that the following changes be made in the present specifications in the paragraph just discussed; (1a) and (1b) being new matter:

(1) A sample of not less than 16 ozs. of the crude asphalt, if any is used, or bituminous rock, together with a statement as to where it was mined.
(1a) A sample of not less than 16 ozs. of any prepared mastic cake or asphalt cake that may be used, along with a statement as to all materials that entered into its composition.
(1b) A sample of not less than 16 ozs. of the asphalt rock pavement, as it will be laid on the street, along with a statement as to the kind and approximate quality of all materials used in its composition.
(2) A sample of not less than 10 ozs. of the refined asphalt to be used in the asphalt paving cement with a statement giving the materials used in its refining.
(4) Samples of not less than 10 ozs. of asphaltic cements which they propose using in both binder and wearing surface, with a statement of the approximate amount of all materials used in their composition.
(7) A sample of not less than 2 lbs. of a paving mixture made with the asphaltic cement which they propose to use, with a statement as to the softness by penetration and quantity of the asphalt cement used and the mesh composition of the sand therein.
(8) A sample of not less than 2 lbs. of a binder mixture made with asphaltic cement such as they propose to use, with a statement as to softness by penetration and quantity of the asphalt cement used therein.

ASPHALT NOT HERETOFORE USED.—Mr. Klein, in his comments on this paragraph in the old specifications, states that it is unnecessary, owing to the definite statements introduced above. I see nothing in what Mr. Klein has stated so far in his specifications that would render this paragraph unnecessary. He has not limited the materials to be used to asphalts of known quality. I do not myself consider this paragraph necessary, as I believe a good paving cement can be determined by tests, but if it is really considered necessary it would be more acceptable if it should read as follows:

Any bidder proposing to offer a material for asphalt paving not heretofore used on streets paved under the jurisdiction of the Department of Highways must in addition to the above requirements file an original certificate along with his samples, stating what pavements, if any, have been laid with the material he proposes to use and if it has not been used, a certificate stating what grounds he has for believing the proposed material will lay good pavement. The acceptance of an asphalt that has not been proven good by use, after a thorough examination, will be at the discretion of the Commissioner of Highways. Any expense incurred in investigating the pavements laid with the new material, or in examining into its qualities, is to be done at the expense of the bidder.

MAINTENANCE PERIOD.—The present specifications require a maintenance period of ten years. The proposed new specifications require a maintenance period of five years. Beside the reasons which Mr. Klein gives, I am of the belief that a maintenance period of five years is sufficient, and that much lower prices can be obtained therewith.

ASPHALT PAVEMENT.—Mr. Klein, in his comments on Paragraph 15 (old), states that it only partially describes the pavement that is to be laid. If only Portland cement concrete is to be used, his proposed changes are advantageous, but as great success has been obtained in New York city by surfacing over old granite block pavements with the binder and wearing surface of the asphalt pavement, I do not see why such constructions should be discontinued.

I would suggest the adoption of the following in place of Paragraph (15 old):

Upon the foundation prepared as specified shall be laid the pavement proper, consisting of either asphalt or asphalt rock. If the surface be of asphalt it shall consist when complete of a binder course laid upon the foundation, 1 in. in thickness, which shall be covered with a wearing surface 2 ins. thick.
Before laying the binder the surface of the foundation shall be thoroughly swept and cleaned from all dirt; and fine particles removed from joints of the block to such depth as may be directed by the engineer.

BINDER COURSE.—In Sec. 16, No. 2,* of the specifications, both the present and the proposed new ones are somewhat off. As I have remarked before, it is hard to conceive why Mr. Klein is so strong in his discrimination of the character of the stone to be used. I can hardly imagine a better material than some crushed boulders or crushed pebbles in engineering work where a crushed stone is desired, let alone a binder of an asphalt pavement where no particular strength is required in the stone, nor can small pebbles along with large angular stone be objectionable.

A fault that is common in both specifications is that they do not permit of the use of sufficient fine material, both limiting it to a maximum of 5% passing a No. 10 sieve. Some fine material is essential in the binder, as it adds to its rigidity, and it would be better to fix a minimum limit of 5% and a maximum limit of 10% passing the No. 10 sieve.

Another fault that is common to both specifications is in the degree of temperature allowed for the stone. Both state that the stone should be heated not higher than 300° F. This means that the binder in the wagon at the paving yard would never be higher than 295° F. After a haul of four miles, which is not at all unusual in New York, on a windy cold day, the binder will not be higher than 270° F. when it reaches its destination, which is rather low for good work. A maximum limit of 350° F. is none too much for some asphalt cements, while the stipulation that the binder must not be defective from overheating will prevent any heating of the stone that would be injurious to an asphalt not capable of standing so high a temperature.

Both specifications state that the asphalt cement for the binder used shall be the same as that used in the wearing surface. This is wrong, as a binder made with such a cement is hard to lay and brittle in cool weather, thus making it liable to break up when hauled over. The use of a softer asphaltic cement is desirable, as it keeps adding to the life of the wearing surface, while at the same time, with a properly graded stone, less asphalt cement is necessary for producing an equally rigid binder. It is also an advantage in cold weather, as it facilitates the laying of the binder.

Neither the present nor the proposed new specifications designate any method for determining the limits of the consistency of the asphalt cement. As there are excellent means of doing this there is no reason for its omission.

Mr. Klein makes a departure from the usual specifications when he limits the percentage of the bitumen soluble in carbon disulphide in the binder, but his limits are too restricted and too low. I am aware that it is possible to construct a binder that would be well coated, and yet contain only 3% bitumen soluble in disulphide of carbon, but such a binder would consist of only large-sized stone, and would be so lacking in rigidity that it would be undesirable for use. Better limits for the percentage of bitumen would be not less than 4% nor more than 7% soluble in carbon disulphide.

I propose the following specifications for the binder course as a substitute for the present one:

(1) Quality and Size of Stone.—The binder shall be composed of suitable clean broken stone passing a 1½-in. screen; between 40 and 60% shall be retained on a ½-screen; 90% of this material must be hard angular stone and the stone, after passing the heating drums, shall not contain less than 5 nor more than 10% of material passing a No. 10 sieve.
(2) Preparation of Mixture.—The stone shall be heated in suitable appliances not higher than 350° F. and then thoroughly mixed by machinery with an asphalt cement of 60 to 80 penetration (District of Columbia standard of hardness) in such proportions that the resulting binder will have life and gloss without any excess of asphalt cement, and in such proportions that the percentage by weight soluble in carbon disulphide shall not be less than 4 nor more than 7%. Should the binder appear dull from overheating or lack of cement it shall be rejected. Should it show rich patches after being rolled with a heavy roller these patches must be removed by the contractor and replaced by suitable material.

Mr. Klein is mistaken when he says that the words "life" and "gloss" are of little significance. They are words that have a meaning to the paving profession, and every man who is at all acquainted with the practical side of asphalt paving knows exactly what quality is required in the binder when it is specified that it should have life and gloss.

SECTION 17, STANDARD PAVEMENT MIXTURE, AND MR. KLEIN'S SUBSTITUTE SECTION AND CRITICISMS.

Section 17, of the present specifications, headed "Standard Pavement Mixture," is open to considerable criticism, not so much on account of its ambiguity, which is only a minor point, but because of its limitations and marked partiality. Par. 2, on refined asphalt, is a copy of specifications gotten up by interested parties for refined Trinidad Lake asphalt, and when the various tests mentioned are performed by methods devised several years ago in the laboratory of one of the local paving companies, no asphalt excepting Trinidad Lake asphalt can comply with them.

The same may be said of Par. 4, on asphaltic cement, for there is no asphalt excepting refined Trinidad Lake asphalt, that when fluxed with between 18 and 21 lbs. of a residuum, such as specified in paragraph 2, to 100 lbs. of the refined asphalt, would give a cement suitable for paving. It is, however, possible, although not so stated, that the above specifications were intended to describe an asphalt cement which was to be considered as a standard. This would be inferred after reading the earlier paragraph, "Asphalt Not Heretofore Used."

Par. 3, on "Heavy Petroleum Oil," is good, excepting for a few minor points, which I will touch on in reviewing Mr. Klein's criticism.

Mr. Klein, in his remarks on Section 17 of the present specifications, starts with a criticism on the probable use of the words "Asphalt" and "Asphaltum" synonymously. Such a criticism in even small type (the original was in caps.—Ed.) is unwarranted under the present confused nomenclature of this subject. I, myself, do not consider these two words as synonymous, but such definitions have not been established either by usage or convention. If Mr. Klein will refer to the "Century Dictionary," and to "Petroleum and Its Products," and several other authorities, he will find that the words asphalt and asphaltum are synonymous.

In his next criticism Mr. Klein remarks for the third time that the term "Refined Asphalt" is ambiguous, open to construction, and that under this head about any material can be admitted. Mr. Klein, in his specifications in the first paragraph under "Wearing Surface," substitutes for the term "Refined Asphalt" the word "Asphalt." In his next paragraph (136) he goes on to define "Asphalt," and we find when he gets through, his "Asphalt" is not what we have always thought it to be, and as he partially defines it in his criticism of Section 17, Par. 1, but really a refined material. And how free from ambiguity is his definition—and does his defining the term "Asphalt" allow of the use of only desirable products? He says:

The word "Asphalt" shall be construed to mean refined Trinidad pitch, refined asphaltum, crude asphaltum that does not need refining, natural extracted bitumen and nothing else.

It is well known that some of the pitch found on the Island of Trinidad is so hardened that it is unsuitable for paving. Such a pitch, if refined, would come under Mr. Klein's definition "Refined Trinidad Pitch." Is the term "Refined Asphalt" any more ambiguous than the terms "Refined Asphaltum" and "natural extracted bitumen?"

Mr. Klein commences his remarks on Par. 2 with "Accomplishes what?" It is evident to any one acquainted with the profession what is accomplished. He then goes on to say that "Refined Asphalts and Refined Trinidad Pitch is never uniform in the same barrel." Asphalt is not refined in barrels, but in large stills. It is a well-known fact that refined asphalt in barrels is not uniform, owing to the subsidation of the mineral matter which takes place while the asphalt is in a molten state; but in a still with proper agitation it is practically uniform after being thoroughly refined.

In further criticising Par. 2, Mr. Klein makes this most remarkable statement:

This requirement is wholly arbitrary. It cannot apply to any asphalt as the richest asphalts contain only about 12% bitumen.

If this is so I would like to know the name of the materials found in nature that contain 20, 30, 40, and, in fact, about any percentage of bitumen that is readily soluble in carbon disulphide. It is evident from this statement that the author has a private definition of his own for asphalt.

As I have before stated, the figures given in Par. 2 of the present specifications apply only to Trinidad Lake asphalt, and they should never have been specified without describing minutely the methods of examination by which they are

*Mr. Klein here changes his numbering of the main divisions of the old specifications from Paragraphs to Sections—Ed.

obtained. Mr. Klein is in substance right in his criticism of this paragraph, but he makes certain statements that are not substantiated by the facts, as, for instance, he says:

It has been found by years of experience that no practical difference is to be observed in the use of well-washed and dried samples of gasoline as they are found on the market (and again), such specific directions as to the specific gravity and boiling point are therefore of no value.

Such specific directions are necessary if anything like concordant results are desired in determining the solubility of asphalt in gasoline or naphtha. I have found that commercial gasolines vary in specific gravity from 659 to 697, and that this is sufficient to give a difference of over 2% in the amount of bitumen they dissolve from the asphalt. In fact, the directions are not sufficiently specific, for, besides stating the specific gravity and boiling point of the gasoline, they should also state minutely by what method the extraction should be made, whether at the temperature of the room by treatment on a funnel, or whether made in an extractor with a return condenser by heat, for the solubility of the asphalt in the same gasoline varies with the temperature of the solvent that comes in contact with the asphalt under examination. The percentage (68) soluble in Pennsylvania petroleum naphtha boiling between 80° and 90° C. is not so high to exclude any refined Trinidad Lake asphalt or Bermudez, as Mr. Klein states, unless the asphalt has been overheated or otherwise hardened, even when the extraction is made at the temperature of the room. Mr. Klein's criticism is at fault, on this point, because he does not state what method of extraction he employs in arriving at his conclusion.

I must beg to differ with Mr. Klein when he says that ductile and malleable are only applicable in metals.

Mr. Klein ends his criticism of Par. 2 by stating that the requirement "It shall soften at 168° F., and flow at 180° F., is positively absurd, as it could not be applied to any one brand of material on the market." The material here under discussion is the extracted bitumen of the asphalt after the solvent has been evaporated, and of course such a material is not on the market. The requirement under discussion is useless, however, because what is here meant by the words "soften" and "flow" is not definitely stated.

In criticising Par. 3, on "Heavy Petroleum," the first remarks made by Mr. Klein are correct if the description of the heavy petroleum is taken literally What I understand the expression "Light oil removed without cracking" to mean is that the distillation is not to be carried on at a high temperature, which causes excessive cracking; but at a moderate heat, accompanied by blowing superheated steam into the still to aid in the removal of the lighter oils. This expression has been used now for so long a time between asphalt men and oil men in differentiating between a residuum produced by very high heat with much cracking and one produced with much less cracking by assisting the distillation by blowing superheated steam, that it has become proper by usage.

In criticising Par. 4, he states that "No composition is stated in the foregoing paragraphs." The composition of the refined asphalt is stated in Par. 2.

The criticisms of the directions for making the asphalt in this same paragraph are unfounded. The description is not vague to one who is acquainted with the art. The statement made by Mr. Klein that they are inadequate because they do not state that the asphaltic material and the oil shall be completely blended. I have never known an instance, where the cement was free from lumps of refined asphalt, and homogeneous, where the asphaltic material and oil were not thoroughly blended.

I agree with Mr. Klein in the statement about the acidity in terms of caustic potash of the liquid asphalt. This test and its relation to the desirability of the liquid asphalt for paving are unknown to me.

Mr. Klein, in his closing remarks, says:

The several varieties of petroleum residues, and particularly those from California, are not excluded, either specifically nor in general terms, whatever may have been intended.

The exclusion of all residue from the California petroleums, which are asphaltic base oils, is too discriminating and unjust. I am personally familiar with several instances where those materials have been used with success in paving. This is also true of Pittsburg flux from the California oils.

After such dogmatic remarks and the severe criticism of this Section 17, in the present specifications, we would naturally hope that the substitute section which Mr. Klein presents would be an improvement, but on examination it is found to be more ambiguous and very nearly as limiting.

In Par. 136 of his proposed specification the definition of the word asphalt is ambiguous, as mentioned before, and for this reason his statement after the definition "and nothing else" is meaningless. It is likely evident that he is trying to exclude asphalts made by different processes from asphaltic oils. This is unwarranted discrimination, as many excellent pavements have been constructed with bitumens made by various processes from these oils.

Pars. 137 and 138, on "Bituminous Flux," are an improvement on the corresponding paragraph in the present specifications. I would suggest, however, in Par. 137, the use of the words "Petroleum Residuum" in place of "Petroleum Tar," as it is a well-defined and the recognized term as applied to such materials; and that "Heavy Petroleum" be omitted, as this term is often applied to heavy petroleum distillates that are objectionable as fluxes for asphalts.

In Par. 140 there is no sense in limiting the dust to "Pulverized Rock." A broader and yet a proper term to use is, any inorganic dust unacted upon by water. Mr. Klein would exclude by his specifications pulverized sand and infusorial earth, both of which are as suitable as what he mentions.

Par. 141 in the proposed specifications is ambiguous and contains unnecessary requirements. There is nothing in this paragraph to tell what properties the asphalt cement should possess excepting that it is to be made by tempering the asphalt with the bituminous flux in such a manner as to properly prepare it for use in the "Asphalt Paving Mixture." This is very ambiguous

Further on in the paragraph he gives some indefinite directions about tempering the asphalt with the flux, and fixes a limit for the maximum amount of flux to be used, that he does not mean himself. He says: "To accomplish this they shall be combined in proportions not to exceed 25 lbs. of 'Bituminous Flux' to 100 lbs. of asphalt." To meet this the parties handling Trinidad Land asphalt will have to use a very light petroleum residuum, or put up with an asphalt cement too hard for the class of sand specified above.

What will Gilsonite do, which, I should judge from remarks in another portion of the paper, is acceptable to Mr. Klein? Gilsonite requires over 50 lbs. of flux to the 100 to temper it into a paving cement.

This would also bar the West Indies Co.'s Cuban asphalt, which has been used in the City of Washington this year; and would preclude the use of maltha for fluxing any Trinidad or Bermudez asphalts.

The paragraph goes on:

The asphalt shall be melted at a temperature not to exceed 350° F. and the bituminous flux, after being heated to at least 250° F., shall be added slowly and the mixture agitated by an air blast, or other suitable means, etc.

These directions for making an asphalt cement are worse than useless—they require procedures that are positively undesirable in some cases, and not essential in any. In tempering Gilsonite and similar asphalts it is desirable that a portion of the flux should be added to the still to assist in melting the asphalt. In no case is it necessary to have the bituminous flux heated as high as 250° F., for just as desirable a cement can be produced by adding the flux cold to the molten refined asphalt.

As I have remarked before, it is useless to try and specify a method of treatment of material so widely different in both composition and physical properties as are the asphalts.

In Par. 142, on "Asphalt Paving Mixture," the limits 12 to 15% are too limiting. With the sand specified it is desirable to have at least 10.5% of bitumen in the mixture, and under some conditions, as high as 12%. If the limits 12 to 15% are enforced with Trinidad asphalt cement, which contain on an average 6% bitumen, no paving mixture would contain as much as 10% of bitumen. Limits that would be sufficiently exacting to make them worth mentioning cannot be applied here, owing to the varying impurities of the different asphaltic cements, nor are they necessary with a clause which is found further on in this paragraph, which limits the total bitumen in the paving mixture. The requirements to which the mixture must conform given in this paragraph are ambiguous, and are open to construction. What are the standards of brittleness, tenacity, hardness and softness that Mr. Klein would use in enforcing the requirements mentioned for his paving mixture?

The limitations in Par. 143 are unjust and unnecessary.

I would suggest as substitute specifications for "Wearing Surface, Section 17," the following:

The wearing surface shall be made and laid according to the following specifications: The materials that shall be used therefore shall be: (1) Refined asphalt; (2) bituminous flux; (3) sand; (4) inorganic dust.

These several words and terms shall be defined and construed throughout these specifications to mean as follows:

(1) "Refined Asphalt"—Any bituminous material having in itself without further change all the properties of a desirable "Asphalt Paving Cement," or a material that when softened with a suitable flux will have all the properties of a desirable "Asphalt Paving Cement," as specified below.

(2) "Bituminous Flux" shall be construed to mean what in commerce is known as Petroleum Residuum, or maltha prepared for use as a flux, by being freed from water and light oils. If it is residuum from paraffine petroleum all its light oils must have been removed by distillation without cracking. From whatever source it may be obtained it shall possess the following characteristics:

(Insert here Pars. 138 and 139 of the proposed new specifications.)

(4) "Inorganic Dust" shall be construed to mean any mineral matter unacted on by water. It shall be of such a fineness that all of it will pass a No. 50 sieve and at least 75% of it shall pass a No. 100 sieve.

(5) "Asphalt Cement" shall be construed to mean a "Refined Asphalt" that has been so tempered by the addition of a "Bituminous Flux" that it will comply with the following requirements, or a refined asphalt that does itself comply with the following requirements:

After the evaporation of the solvent the pure bituminous matter soluble in carbon disulphide must have a consistency at 100° F. of not more than 125 penetration (District of Columbia Standard) and a consistency at 32° F. of not less than 12 penetration (District of Columbia Standard). When 50 grams of the extracted bitumen are kept at a temperature of 300° F. in an open tin for 18 hours, the bitumen must not show by penetration a hardening of over 100%. The bitumen must compare favorably in adhesiveness and ductility with a bitumen of the same penetration at 77° F., extracted in a similar manner from a cement made of the best quality of refined Trinidad asphalt and a good quality of petroleum residuum of 20° B. gravity. The less an asphalt cement is acted on by water the more desirable will it be considered.

In the manufacture of the "Asphalt Cement," the "Bituminous Flux" and the "Refined Asphalt" must be thoroughly agitated together at a temperature of not less than 300° F. nor more than 350° F. until a homogeneous cement is obtained. When an Asphaltic Cement contains more than 10% of foreign matter it must be thoroughly agitated just before and while being used.

(6) "Asphalt Paving Mixture" shall be construed to mean a mixture of "Asphaltic Cement," "Sand" and "Inorganic Dust." The proportions of these ingredients shall be determined by weight and shall depend upon their kind and qualities, and the traffic upon the street, and will be determined by the Commissioner of Highways, but the percentage of bitumen in any mixture soluble in carbon disulphide shall not exceed the limits 9 to 13%. If the proportions of the mixture are varied in any manner from those specified the mixture will be condemned; its use will not be permitted; and, if already placed on the streets, it will be removed and replaced by proper materials at the expense of the contractor.

The sand, or the mixture of sand and stone dust, and the Asphaltic Cement, will be heated separately to about 300° F. The dust, if limestone, will be mixed while cold with the hot sand in the required proportions, and then mixed with the Asphaltic Cement at the required temperature, and in the proper proportion in a suitable apparatus, so as to effect a thoroughly homogeneous mixture. Sand boxes and asphalt gages will be weighed in the presence of inspectors as often as may be desired, and all samples desired shall be supplied in suitable boxes to the Commissioner of Highways.

The pavement mixture prepared in a manner thus indicated will be brought to the ground in carts at a temperature of not less than 250° or more than 350° F., and if the temperature of the air is less than 60° F., the contractor must provide canvas covers for use in transit.

(The following paragraphs should be inserted here.)

(7) Standard Methods of Testing.—A detailed descrip-

tion of the processes that shall be employed in the testing of the various materials will be kept on file in the office of the Commissioners of Highways and the results obtained by these various methods shall be considered as the standards for the requirements mentioned in this specification. They will be at all times accessible to the contractors.

In closing, I will state that there are several minor points that I have not considered of sufficient moment to warrant criticism. The portions of the specifications that I have presented as substitutes for paragraphs in the present specifications have been presented merely as suggestions that may aid in the compiling of a more desirable specification.

ANNUAL MEETING OF THE INDIANA ENGINEERING SOCIETY.

The 22d annual convention of this society was held at Indianapolis, Ind., Jan. 29, 30 and 31, the meeting being held at the State House, and headquarters being at the Hotel English. As a rule, the opening sessions of such conventions are lightly attended and are largely informal, the less important matters on the program being generally assigned for this meeting, to give time for members to gather for subsequent sessions. At the meeting of the Illinois Society of Engineers, for instance (reported last week), there were hardly a dozen persons present to hear the address of welcome. The Indiana Society, however, put some of its strongest papers on the program for the opening session, with the result that there was a good attendance, some 35 or 40 members being present.

The President, Prof. W. D. Pence (Purdue University), delivered the opening address, in which he discussed the aims and growth of the society and the necessity for the co-operation of all members in furthering its progress. The report of the Secretary, Mr. C. C. Brown (Indianapolis), showed a membership of 83, and a cash balance of $25. The following resolutions on municipal statistics were carried, being similar to resolutions adopted by a number of other societies:

In the opinion of the Indiana Engineers' Society, the U. S. Census Bureau should include municipal statistics in its enquiries, particularly those relating to municipal public works; the same to be published at less intervals than 10 years. The society approves of the proposed establishment of a permanent census or other statistical bureau at Washington, whose organization should include experts in the engineering, finance, etc., of municipal public works.

The report of the Committee on Materials of Construction was then presented by Mr. W. K. Hatt, of Lafayette. It outlined recent movements and progress in the attempt to standardize methods of testing materials, and gave particulars of methods of testing various materials. It also suggested the establishment of a central bureau, supported or controlled by the State of Indiana, at which engineers and municipal authorities can have materials tested and reported on by experts at a nominal cost. A paper on "Portland Cement" was then read by Mr. S. B. Newberry, of Sandusky, O. The special feature of this meeting was the attention given to concrete and concrete-steel construction. Mr. D. B. Luten, of Lafayette, read a paper on "Concrete Arches," in which he showed the remarkable development of the use of concrete as a structural material within the past few years. He contrasted the special features of stone and concrete arches, and showed that the latter are now being quite extensively adopted for highway bridges. In discussing this paper, Mr. J. B. Nelson, City Engineer of Indianapolis, showed a number of stereopticon views of concrete and concrete-steel bridges in Marion county. The last paper of the afternoon session was on "The Strength of Reinforced Concrete," dealing with the question of computation of strains, etc., a matter over which there is at present great difference of opinion. We expect to present abstracts of the above two papers in a later issue.

At the evening session, Mr. A. L. Johnson, of the St. Louis Expanded Metal Fireproofing Co., read a paper on "Steel-Concrete Construction," illustrated by stereopticon views, showing floors and roofs, complete buildings, sewers, arches, reservoirs, culverts, oil tanks, a long dust-flue or conduit for a smelting plant, and a variety of other structures built of concrete reinforced by corrugated bars, rods, sheets of expanded metal, etc. He claimed that such material formed a class in itself, entirely different from plain concrete, but Mr. Luten expressed some doubt as to the advantages of certain of the proposed combinations of steel and concrete. The lengthy report of the Committee on Bridges and Masonry was read by Mr. G. E. Waesche, of Lafayette. This dealt with highway bridges only; the live and dead loads prescribed in different localities, floor construction and paving, painting and maintenance; bridge abutments and timber truss bridges were also briefly considered.

On Thursday morning, Jan. 30, Mr. F. W. Keller, of South Bend, read a short paper on "Masonry Arches," in which he described the construction of a 15-ft. arch for a highway bridge, at a cost of $7,800. In the general discussion on bridges, Prof. Sackett (Earlham College), of Richmond, showed that on certain spans a 10-ton traction engine might cause greater bending moments than an 18-ton electric car, on account of the greater concentration of the load. He advocated a law requiring the county surveyor to prepare the plans for small structures, and the employment of a consulting engineer for larger structures, taking this out of the hands of the county commissioners. Mr. Keller mentioned a case of a masonry arch bridge which was built of rough rubble masonry for the arch, cut ring stones being used only in the face; this structure was accepted by the commissioners. Mr. D. B. Luten remarked that in some cases the depth of foundation of side walls may be reduced if the waterway is paved. Prof. Sackett's suggestion was referred to the Bridge Committee.

The report of the Committee on Surveying was read by Mr. H. B. Fatout, of Indianapolis, and discussed the best way of dealing with surplus land found by accurate measurement, due to the use of a "long" chain in the original survey. He also referred to the difficulty of keeping monuments undisturbed. This was followed by an interesting discussion, with numerous instances of defective surveys and plots, in the course of which Prof. Sackett referred to the excellent requirements of the Michigan law. On his motion the Committee on Surveys was instructed to report at the next meeting on a law calculated to introduce a uniform practice in surveying, monumenting and recording lands divided into lots. This discussion showed that the surveyor, as distinguished from the engineer (to use the commonly accepted meaning of the latter term) is a more important member of the profession than is generally understood in these days.

A brief report of the Committee of Drainage was read by Mr. F. W. Keller, showing that a great amount of private and public work for ditch and tile drainage is in progress, while the Governor has appointed an engineer to examine into the question of completing the drainage of the Kankakee marsh. This was followed by a paper on "Drainage Improvement by Dredging," by Mr. E. E. Watts, of Princeton. This described the method of surveying swamp lands and locating the drainage channel. Dipper dredges are mainly used, and elevator or ladder dredges only occasionally. It may be a traction dredge or a floating dredge, the latter commencing work at the head of the ditch. To deposit the material far enough from the cut, the dredge should have a long boom, or else be fitted with a crowding engine, so as to run the bucket farther out before dumping. He advocated making the bottom of the cut segmental. An abstract of this paper will be given later. A discussion on "The Ditch Laws of the State" followed, and on motion of Prof. Sackett a proposed change in the law, to more justly distribute assessments for ditch repairs, was referred to the committee.

A paper on "Plumbing of Buildings and Residences" was read by Mr. J. S. Humphreys, of Alexandria. In that city sewer connections are required to be of 4-in. pipe, with a fall of 1 in 48; inspected by the engineer before the trench is filled. After all the fixtures are in place, the peppermint test or smoke test is made to detect any leakage. A paper on "The Measurement of Water" was then read by Mr. C. V. Seastone, of Lafayette. This described the different methods employed, advocated the nozzle flow method as being the best, and described a special form of apparatus devised for regulating and measuring the flow. Mr. J. W. Fawcett, of Delphi, read a paper on "A Tippecanoe River Water Power," describing a new project. The dam will be about five miles from Delphi, where the river makes three reverse bends; there is a fall of 9 ft. in the river, which, with the 15-ft. dam, will give a total head of 24 ft., developing 3,850 HP. The dam will be of pile and timber construction, with plank sheathing, and will be 300 ft. long. The power canal will be 50 ft. wide on the bottom, and carry 7 ft. of water.

In the afternoon, Mr. F. A. W. Davis, Jr., of the Indianapolis Water Co., exhibited the plans of the new pumping engine now being built, which is a triple-expansion vertical engine, with gridiron valves and a new type of valve gear. The large engine built by the Snow Steam Pump Co. a few years ago (20,000,000 gallons daily capacity) was built to the company's designs, and the new engine is of the same general type but with modifications suggested by experience. The contract has been let to a general foundry and machine works, which has never before built an engine of this type, but the company prefers to have its own plans rather than to have an engine built to the plans of a pump company. Mr. L. G. Weis, also of the water company, then described the air-lift system as in use at the company's wells. These addresses being concluded, the party was taken in carriages to the water company's pumping plant and wells, the latter being located in the private park maintained by the company. The pump house for the new engine is a very handsome work of architecture. After some time spent at this point the party was driven to the West Washington St. bridge, whose center span collapsed about two weeks ago. The bridge had three spans, with arched top chords composed of two plates separated by cast-iron spreaders, and all put together with bolts. It was built in 1871, and had been considered dangerous for seven or eight years past, but the city failed to take any action towards its reconstruction, but directed certain repairs to be made, although the bridge was not of a proper type or proper strength to carry the heavy street railway traffic to which it was subjected

At the evening session, the first paper read was by Mr. E. C. De Wolfe, of Mishawaka, on "Power Transmission as a Distinctive Branch of Mechanical Engineering." He showed that only within recent years has the economic side of power transmission been given careful study. After considering the various methods of transmission he expressed the opinion that under certain conditions mechanical transmission has advantages over electrical transmission. Prof. Goldsborough, of Purdue University, rather took exception to this, and pointed out the advantages of the electrical system, while Mr. Waesche briefly described the equipment of the new shop at the Toledo works of the American Bridge Co., where nearly all tools have their own motors, shafting being used only for the multiple drills. Mr. De Wolfe defended his position and instanced the case of two cotton mills in South Carolina. One has rope transmission, with which there is no trouble; the other has electric transmission, with motors on the shafting, and this is always giving trouble. The reason is that the latter requires more careful attention, which it does not receive. A paper on "The Conversion of Heat into Power in the Steam Engine" was then read by Mr. Rollin Defrees, of Indianapolis; this described the old theories concerning steam, the discovery of the mechanical equivalent of heat, and the conversion of heat by steam into power.

A short talk on "Electric Street Lighting" was then given by Prof. W. E. Goldsborough, of Lafayette, his remarks referring to open and enclosed arc lamps and being illustrated by a number of stereopticon views. A brief report of the Committee on Stream Pollution was read by Mr. A. J. Hammond, City Engineer of South Bend. It simply stated that papers on this subject had been secured, and recommended that the investigation be continued. This was followed by a paper by Prof. R. L. Sackett on "Health Laws and Court Decisions on Stream Pollution," showing the laws of other states concerning this matter, and showing also that in Indiana the State Board of Health has only advisory powers and has no appropriation enabling it to conduct investigations. He considered that there should be an engineer member of the board. Prof. Severance Burrage, of Lafayette (Purdue University), then read a paper on "The Chemical and Bacteriological Side of Stream Pollution," illustrated with stereopticon views. This was followed by a paper on "The Present Condition of the Streams in Indiana Regarding Pollution," by Mr. A. J. Hammond, in which he described the conditions in a number of counties. He stated that the conditions were becoming very serious, but the matter has been in part overlooked from the fact that most of the cities of the state draw their water supply from underground sources and not from the streams. The whole subject received interested attention, but discussion was postponed on account of the lateness of the hour.

On Friday morning, Jan. 31, Mr. F. A. W. Davis, of the Indianapolis Water Co., spoke strongly as to the dangerous conditions of the streams resulting from the operations of the strawboard factories, the wealthy interests backing which will not make the efforts they should make to prevent the absolutely deadly pollution of the streams by the refuse. Dr. Hurty, of the State Board of Health, discussed the same subject very forcibly, showed the powerlessness of the board under the present law, and advocated legislation to remedy the present situation, a bill for this purpose having been very nearly passed by the last Legislature. He indicated how the various industrial wastes could be treated and purified, and considered that the law should include cities and sewage, as well as factories and waste. Prof. Sackett described a sewage purification plant put in at a summer resort at Rome, Ind., by the Grand Rapids & Indiana R. R. It has 6,500 sq. ft. of sand bed, 5 or 6 ft. deep, filtering 300,000 gallons per acre per day. Resolutions were adopted favoring such legislation as was outlined by Dr. Hurty, and directing the Committee on Stream Pollution and the Executive Committee to devise means by which the society can aid in procuring this legislation.

The Committee on Bridges and Masonry presented a draft of a bill requiring plans for bridges and culverts costing up to $2,000 to be made by the county surveyors; for more expensive structures a consulting engineer must be employed, the county surveyor to make surveys and plans for the approaches and abutments. This was referred to a committee, which will report at the next meeting. The report of the Committee on Roads and Pavements was read by by Mr. A. W. Smith, of Kokomo, and suggested several topics, which were briefly discussed. He then read a paper on "Needs of Maintenance," dealing with both streets and roads. This brought out a little discussion as to present unsatisfactory methods, but nobody seemed able to suggest any practical remedy. The last paper was on "The Cost of Gravel and Macadam Roads in Indiana," by Mr. O'Brien, which gave the average cost as $1,925 per mile for gravel and $2,402 for macadam.

The next meeting will be held at Indianapolis in 1903. Officers were elected as follows: President (re-elected), Prof. Wm. D. Pence (Purdue University), of Lafayette. Vice-President, Prof. R. L. Sackett (Earlham College), of Richmond; Executive Committee, J. S. Spiker, of Vincennes; J. S. Humphreys, of Alexandria; C. G. H. Goss, of Martinsville, and F. W. Keller, of South Bend; Secretary, C. C. Brown, of Indianapolis.